IRRIGATION WATER SOURCE: EFFECT ON SOIL NUTRIENT DYNAMICS AND MICROBIAL COMMUNITY COMPOSITION

A Thesis

by

LEON CARL HOLGATE

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

May 2010

Major Subject: Soil Science

IRRIGATION WATER SOURCE: EFFECT ON SOIL NUTRIENT DYNAMICS AND MICROBIAL COMMUNITY COMPOSITION

A Thesis

by

LEON CARL HOLGATE

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

Approved by:

Co-Chairs of Committee,	Jacqueline Aitkenhead-Peterson
	Terry Gentry
Committee Members,	Kevin McInnes
	Richard White
Head of Department,	David Baltensperger

May 2010

Major Subject: Soil Science

ABSTRACT

Irrigation Water Source: Effect on Soil Nutrient Dynamics and

Microbial Community Composition. (May 2010)

Leon Carl Holgate, B.S., Prairie View A&M University

Co-Chairs of Advisory Committee: Dr. Jacqueline A. Aitkenhead-Peterson
Dr. Terry J. Gentry

Maintaining a supply of potable water is a growing concern in the USA, particularly in many southern and western states. One method of sustaining water supply in these areas is the use of greywater for commercial and residential landscape irrigation. Greywater is derived from residential use such as showers, laundering and bathing, and accounts for approximately 65% of residential waste water. I investigated the effects of municipal tap water, harvested rain water, washing machine and bath water (greywater) on the carbon and nutrient dynamics of soil, foliage and leachate and on soil microbial diversity. I also examined the presence or absence of *E. coli* in source water and leachate. There was a significant difference in leachate chemistry among irrigation treatments. Average leachate pH and conductivity was significantly lower in treatments irrigated with harvested rain water. Fertilization did not affect any of the leachate chemistries with the exception of orthophosphate-P, but significantly reduced carbon in soil without grass (blank) and domestic tap water treatments. *E. coli* colonies were detected in source water (greywater), but not in leachate suggesting that there was no movement through the soil profile. The results of principal component analysis (PCA) on whole-soil fatty acid methyl ester (FAME) profiles indicated distinct differences in soil microbial community composition due to irrigation with greywater as compared to rainwater, suggesting that water source may affect soil microbial community composition.

DEDICATION

This thesis is dedicated to my two sons Jayden and Jerron Holgate. Their input was of vital importance to this study. When they grow up, it should be a great story to tell them that just by taking a bath, they made a contribution to science. This research is important to their future and the rest of the world, as it provides information important for solving this puzzle of declining potable water supply.

ACKNOWLEDGEMENTS

I would like to thank my committee co-chairs, Dr. Jacqueline Aitkenhead-Peterson and Dr. Terry Gentry, and my committee members, Dr. Kevin McInnes and Dr. Richard White, for their guidance and support throughout the course of this research. Thank you to Texas Water Resources Institute (TWRI) for the Mills Scholarship award that assisted with sample analysis. The Department of Soil and Crop Sciences at Texas A&M University, College Station provided stipend support, and Texas AgriLife Research provided support for the design, execution and chemical analysis involved in this research.

Thank you to Nina Stanley and Heidi Mjelde for their help with laboratory procedures, and to Paul Delaune and Tim Rogers for their help with foliar and soil C and N analysis. Thanks to my lab group Cara Harclerode, Meredith Steele and Sarah Robinson for their help with sample preparations, discussions and ideas. I would also like to thank the Soil and Crop Science Department faculty and staff for making my time at Texas A&M University a great experience.

Finally, thanks to my wife Rhonda and my sons Jayden and Jerron and the rest of my family for their continuous love, support and encouragement.

NOMENCLATURE

C	Carbon
DOC	Dissolved Organic Carbon
DON	Dissolved Organic Nitrogen
FAME	Fatty Acid Methyl Ester
MTW	Municipal Tap Water
mTEC	membrane Thermotolerant *Escherichia coli*
N	Nitrogen
P	Phosphorus
PLS	Pure Live Seed
TDN	Total Dissolved Nitrogen

TABLE OF CONTENTS

Page

LIST OF FIGURES

FIGURE | Page

LIST OF TABLES

1. INTRODUCTION

Demand for, and maintaining a supply of potable water is a growing concern in the USA particularly in many southern and western states. Sources of water used for domestic and commercial potable supplies include surface waters; rivers, lakes and reservoirs, and groundwater; deep aquifers and shallow alluvium groundwater. Over the last one hundred years, river and lake depths have decreased and aquifer volume has been reduced dramatically due to population increase and the concomitant demand for potable and irrigation water. At the beginning of the twenty-first century, the Earth, with its diverse and abundant life forms, including over six billion humans, is facing a serious decline in potable water supply. All the signs suggest that this water crisis is getting worse and will continue to do so, unless corrective action is taken (UN/WWAP, 2003).

Agricultural and horticultural irrigation is the largest user of fresh water in the United States and totaled 518 X 10^9 gallons of water a day for irrigation purposes in 2000. Since 1950, irrigation has accounted for about 65 percent of total water withdrawals, excluding those for thermoelectric power (Figure 1). Historically, more surface water than groundwater has been used for irrigation. However, the percentage of total irrigation withdrawals from groundwater has continued to increase, from 23 percent in 1950 to 42 percent in 2000. Irrigated acreage more than doubled between 1950 and 1980, then remained constant before increasing nearly seven percent

---

This thesis follows the style of Soil Science Society of America Journal.

between 1995 and 2000. The number of acres irrigated with sprinkler and micro-irrigation systems has continued to increase and now comprises more than one-half of the total irrigated acreage (Hutson et al., 2004).

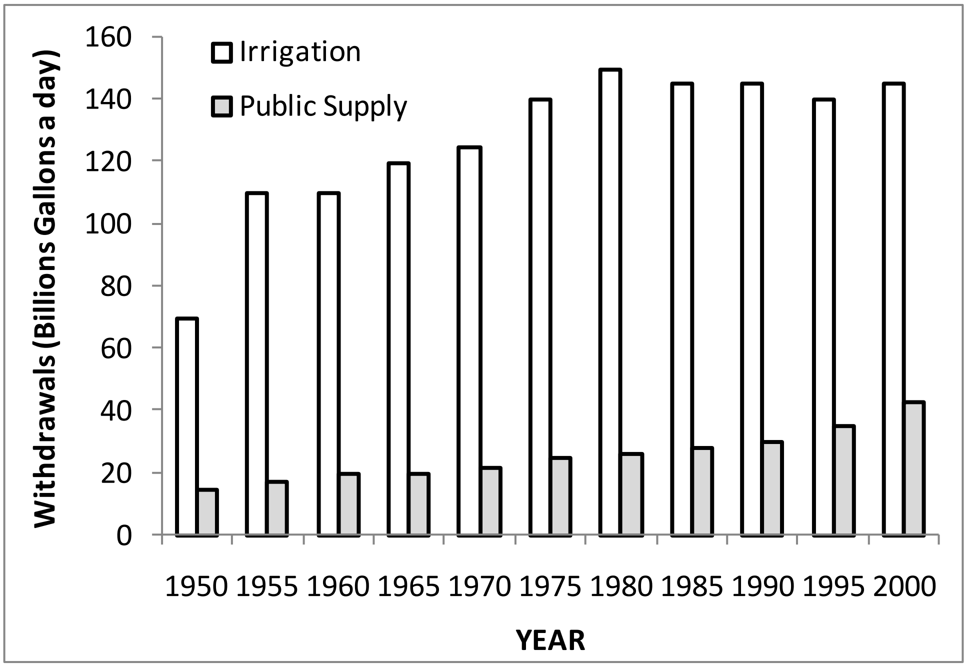

Figure 1. Trends in water use withdrawals 1950 to 2000. Adapted from Hutson et al., (2004).

Growing populations in communities in the United States will face different water supply and demand issues (Hilaire et al., 2008). In the United States, the yearly average residential water use ranged from a low of 208.4 $L{\cdot}d^{-1}$ per person in the temperate mesic state of Wisconsin to a high of 784.5 $L{\cdot}d^{-1}$ per person in the arid state of Nevada (Emrath, 2000).

Other parts of the world are faced with similar problems to those in the USA that reduce potable water quality such as urban development, human activities and industrialization. These problems deteriorate the quality of water and, in some cases, make it unsafe for consumption (Sazakli et al., 2007). In numerous Asian coastal cities, the rapid increase of human population in urban areas has resulted in excessive groundwater withdrawals, causing large-scale problems such as land subsidence and salinization (Hayashi et al., 2008). Onodera et al. (2008) examined the effects of urbanization on contaminant transport in groundwater around Bangkok, Thailand, and Akarta, Indonesia. They concluded that surface water was not suitable for drinking because of contamination and insufficient volumes. As a result, groundwater potential decreased and land subsidence occurred because of intensive groundwater pumping in urban areas (Onodera et al., 2008).

In addition to increasing populations, pesticide and fertilizer runoff from agricultural operations (Blanchoud et al., 2007); industrial waste (Botalova et al., 2009) and runoffs from impervious surfaces such as paved roads and parking lots (Bian and Zhu, 2009), also play an important role in the declining quality of potable water sources, as these sources transport chemicals that contaminate surface water and eventually groundwater systems.

Other sources of surface water contamination are produced water; this is water that contains oil and is trapped in underground formations that is brought to the surface along with oil or gas production. It can contaminate soil resulting in de-vegetation and the subsequent erosion of topsoil. Impacted soil may ultimately contaminate surface waters and shallow aquifers (Abdol Hamid et al., 2008).

Management of our water sources (surface and groundwater) is therefore essential to maintaining continuous supply of potable water. With good management many of the factors aforementioned which include urbanization, industrial and municipal waste, will not significantly impact our water sources.

1.1 Alternative sources of water for irrigation use

1.1.1 Greywater

Greywater is derived from residential uses such as showers, laundering and bathing (Chen, 2007). About 65% of the domestic water demand is transformed into greywater, the specific discharge of which ranges between 60 and 120 L/capita/day. Thus, reuse of greywater can significantly reduce potable water demand and enhance sustainability of water utilization (Friedler et al., 2006).

Greywater can vary significantly in composition (Hernandez Leal et al., 2007). As a result, there are concerns of the effect of its usage on the environment. Its composition is dependent on several factors; these include number and age of household occupant, types of greywater storage and source of greywater (Casanova et al., 2001b). These factors influence microbial quality of greywater, total nitrogen and total phosphorus (Hernandez Leal et al., 2007). However, regardless of its composition, greywater recycling is now accepted as a sustainable solution to the general increase of the fresh water demand, water shortages and for environmental protection (Pidou et al., 2008). This is because characterization of grey water reveals a source water that is similar in organic strength to a low-medium strength municipal sewage influent but with physical and biodegradability characteristics similar to a tertiary treated effluent (Jefferson et al., 2004).

Casanova et al.(2001a) conducted a survey of the microbial quality of recycled household greywater. In their analysis, there were differences in the counts of fecal coliforms in greywater from households with and without children. They reported that children may increase greywater fecal coliform load. They also found higher counts of fecal coliforms in greywater irrigated soils in households using aboveground storage than in households using in-ground tanks. The time of year and the use of kitchen sink water also influenced the fecal coliform numbers in greywater.

Wide ranges of values for macro pollutants and nutrients in greywater have been published; for instance, chemical oxygen demand (COD) has been reported at between 13 and 550 mg L^{-1}; biological oxygen demand (BOD) 90 to 360 mg L^{-1}; total nitrogen 0.6 to 74 mg L^{-1} and total phosphorus 4 to 14 mg L^{-1} depending on the use of detergents with or without phosphate (Eriksson et al., 2002).

The critical importance of water to sustainable development is clearly recognized in the Millennium Development Goals (MDGs), which represents a global partnership that has grown from the commitments and targets established at the world summits of the 1990s. Freshwater is a fundamental requirement for human survival and socio-economic development and must therefore be wisely managed. Reducing the needs for fresh water can be achieved by recycling greywater. Greywater has great potential for reuse due to its availability and its low concentration of pollutants when compared with combined household wastewater (Hernandez Leal et al., 2007).

1.1.2 Harvested rain water

Rainwater harvesting may also serve as an alternative solution to increase water availability for irrigation in urban areas, particularly for the horticultural sectors, parks and amenities and homeowners. Harvesting of rain water has been a common practice in many nations around the world for thousands of years, especially in arid or remote areas where the provision of water through piped networks is uneconomic or not technically feasible (Sazakli et al., 2007). Even though such a solution seems attractive from an ecological point of view, potential health risks of harvested rainwater related to microbiological and chemical contaminants should be taken into account. Chang et al., (2004) examined the runoff quality for four commonly used roofing materials (wood shingle, composition shingle, painted aluminum, and galvanized iron) at Nacogdoches, Texas as a potential source of nonpoint water pollution. According to Chang et al (2004), roof runoff is considered a potential source of nonpoint pollution due to compounds contained in 1) roofing materials that may be leached into runoff, 2) airborne pollutants and 3) organic substances, such as leaves, dead insects, and bird waste, which are added to roofs by interception and deposition. They reported that their rain water samples had concentrations of Cu and Zn and pH levels exceeding the EPA freshwater quality standards even without pollutant inputs from roofs. Zinc (Zn) and copper (Cu), the two most serious pollutants in roof runoff, exceeded the EPA national freshwater water quality standards in 100% and more than 60% of their samples, respectively. Chemical contamination of the rainwater can also occur due to traffic emissions and industrial pollution in urban areas or due to agricultural usage of fertilizers and pesticides in rural areas (Sazakli et al., 2007).

Microbial pathogens may originate in fecal contamination by birds, mammals and reptiles that have access to catchment areas or water storage tanks (Evans et al., 2006). Although collected rainwater is typically consumed without any type of disinfection, the microbial quality of this type of water source can be poor. Around the world, consumers of collected and stored rainwater may be at considerable risk to a variety of infectious diseases (Lye, 2002).

1.2 Objectives

The major objective of this study was to investigate the effect of four different irrigation water types, municipal tap water (MTW), harvested rain water, harvested washing machine water (greywater), and harvested bath water (greywater) on the nutrient dynamics of soil, foliage and leachate. The second objective was to determine 1) the presence of *E. coli* in our irrigation water sources, 2) the presence of *E. coli* in leachate and 3) the effect of the different irrigation source water on soil microbial diversity.

1.3 Hypotheses to be tested

HO-1 There will be no significant difference in leachate chemistries among fertilized, unfertilized or irrigated treatments.

H1 Fertilization will significantly affect the leachate chemistry because of the increase in nitrogen, potassium and phosphate.

H2 Irrigation treatment will significantly affect the leachate chemistry because there will be significantly higher input orthophosphate-P in the two greywater treatments from detergents, soaps and shampoos.

H3 There will be a significant interaction effect between fertilization and irrigation treatments on leachate chemistries.

HO-2 Fertilization and irrigation treatments will not significantly affect foliar carbon and nitrogen.

H4 Fertilization will significantly affect foliar carbon and nitrogen.

H5 Irrigation will significantly affect foliar carbon and nitrogen because there will be significantly higher input orthophosphate-P in the two greywater treatments from detergents, soaps and shampoos.

H6 There will be a significant interaction between fertilization and irrigation treatment that will cause significant differences in foliar carbon and nitrogen.

HO-3 There will be no significant difference in soil carbon and nitrogen after 20 weeks of greywater addition.

H7 There will be a significant difference in soil carbon and nitrogen when comparing week 0 and week 20 due to the addition of fertilizer and addition of ions in irrigation input water.

HO-4 There will be no significant difference in microbial diversity among treatments

H8 Input irrigation source water containing high concentrations of nutrients (bath and washing machine water) will induce increased soil microbial diversity.

HO-5 Fertilization and irrigation will not significantly affect biomass production and biomass-N.

H9 Fertilization combined with greywater irrigation will significantly increase biomass production and biomass-N compared to unfertilized treatments with either domestic tap water or harvested rain water irrigation.

2. MATERIALS AND METHODS

2.1 Experimental design

This experiment consisted of four water treatments; 1) domestic tap water (control), 2) harvested rain water, 3) bath water and 4) washing machine water, the latter two treatments being greywater. One grass species was examined; perennial ryegrass (*Lolium perenne L.*) with six replicates per treatment (three fertilized and three unfertilized) (Figure 2). A total of 27 pots (diameter 20 cm and 17.5 cm depth) were labeled with their respective irrigation treatment. Each pot contained the following 1) Vigoro® pea-gravel at a bulk density of 1.3 $g{\cdot}cm^{-3}$ and a depth of approximately 2 cm for drainage, 2) a Quikcrete® commercial grade, medium sand (No. 1962-51) at a bulk density of 1.3 $g{\cdot}cm^{-3}$ and depth of 9 cm and 3) turfgrass sod layer. Fourteen seed trays (L50 cm x W26 cm x D6 cm) were filled with Timberline® sandy top soil at a bulk density of 1.3 $g{\cdot}cm^{-3}$. To produce a turfgrass sod layer, perennial ryegrass seeds were added to the topsoil in twelve of the seed trays. Six of the trays received a starter fertilizer and six did not. The two additional seed trays with topsoil were blanks (contained no seeds), one of which received a starter fertilizer and one did not. The seed trays were irrigated with domestic tap water until the ryegrass had reached a height of 5-7.5 cm (approximately 4 weeks). Domestic tap water was used for initial irrigation prior to commencement of irrigation treatments because I considered that at a typical sod farm domestic tap or well water would likely to have been used for irrigating turf during establishment.

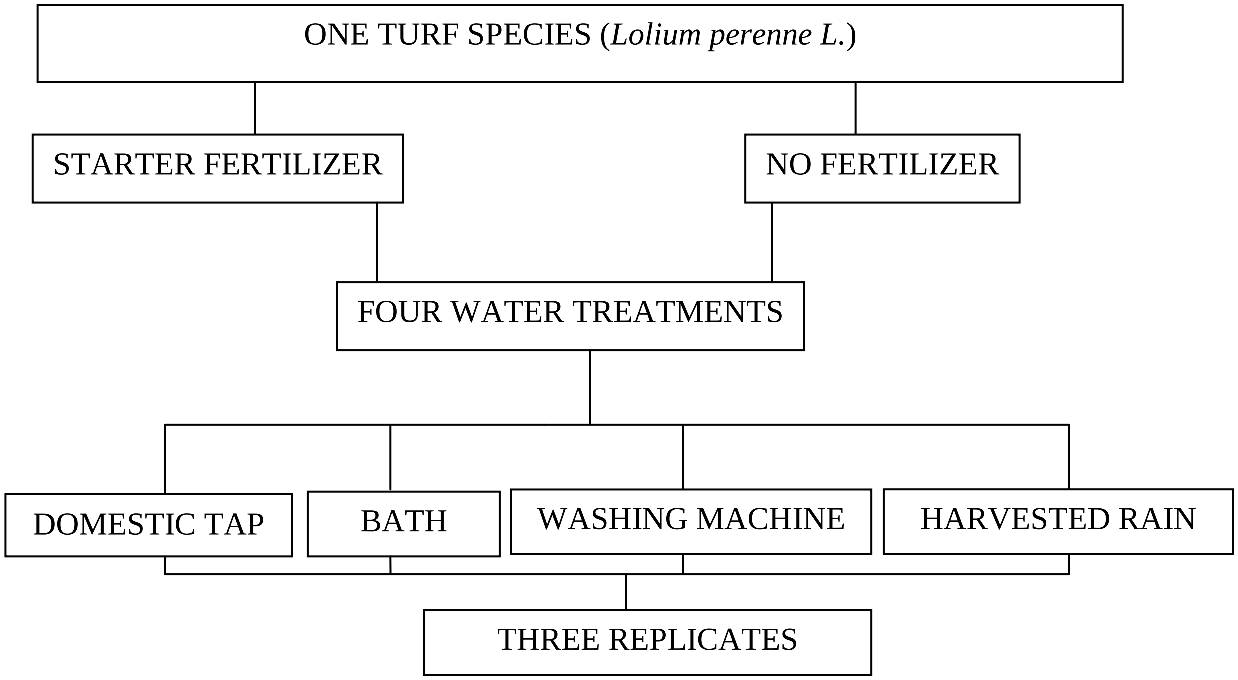

Figure 2. Layout of experimental design.

The bulk density of each medium layer in plant pots was achieved by measuring the volume (cm^3) for the layer of pea-gravel and sand. Bulk density of the topsoil in the seed trays was achieved from the measurement of the volume of half the depth of the trays. Each medium weight was recorded and bulk density for each medium layer was calculated using Eq.1.

Equation.1 $$\textbf{Bulk Density} = \frac{\textit{Mass of layer}}{\textit{Volume of layer}}$$

Seeds were planted at a pure live seed (PLS) rate of 11 seedlings per square inch (Christians 1998). The quantity of seeds and fertilizer used per seed tray were:

- Perennial ryegrass – 7g seeds/seed tray.
- Starter fertilizer (Scotts Starter® Brand, Marysville, Ohio; 10N-27P_2O_5-5K_2O) - 2.5g in each seed tray (equivalent to 8.1kg per 464.5 m^2).

The table surface where pots were placed was covered with card board to block light to the base of pots. Pots were placed in vinyl plant saucers. The exterior of the vinyl plant saucers were spray painted black to block light from the base of pots. This measure was initiated to protect against algal growth which would compromise the experiment in terms of C, N and P cycling.

A rigid but fairly light weight wood/wire frame was constructed with 2.5cm x 5cm x 15cm top choice whitewood board, used for the perimeter of the frame and the center support. Four pieces of 5cm x 5cm x 3.75cm premium furring strips were used for the upright support. Galvanized poultry netting was placed on the top of the frame and secured with double point tacks. Multiple 3.75cm long wood screws were used as fasteners for the wood frame (Figure 3).

With a heated 15cm piece of 19 gauge galvanized wire, 5 holes (approximately 0.91mm diameter) were burnt into the bottom of each plastic cup. This was done to gradually deliver treatments introduced to each cup to the pots. The five holes delivered treatment to each pot at an average flow rate of 2.5mL/sec. This avoided a fast delivery which could encourage preferential flow paths.

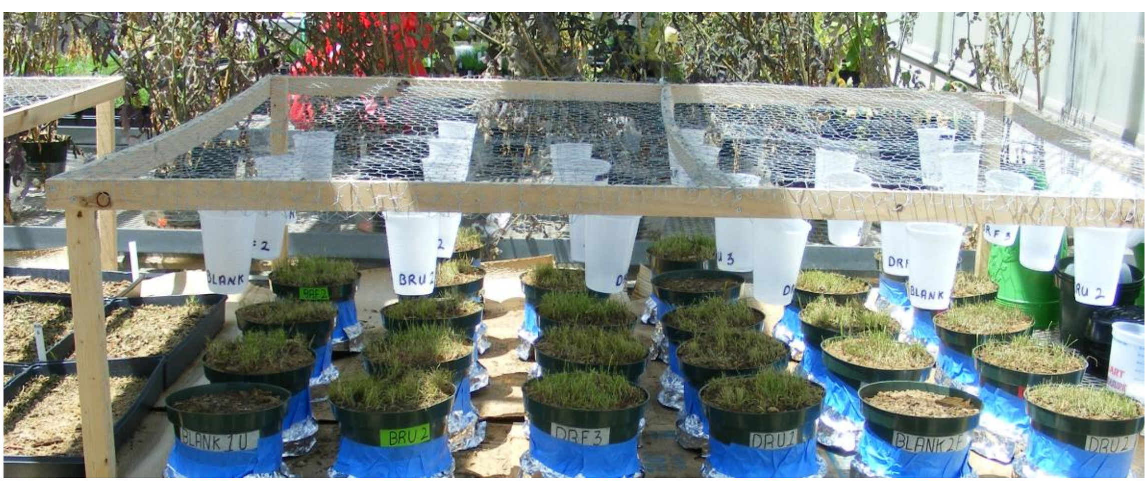

Figure 3. Layout of wood/wire frame with plastic cups above pots.

2.2 Irrigation water

Rainwater was harvested throughout the spring and stored at room temperature in a 170L plastic drum and aerated with an Aqua Culture® 76-227L aquarium air pump. The drum was covered with aluminum foil to block light and placed in a dark room to prevent algal growth.

Bath and washing machine greywater were collected fresh every month in 26L bottles (AQUA - TAINER™), and stored in the greenhouse. Rain water was also collected from the 170L drum monthly into a 26L bottle (AQUA-TAINER™) and stored in the greenhouse. Bottles were aerated with Aqua Culture 76-227L aquarium air pumps. A sub-sample was collected from every new batch of greywater collected for chemical analysis and *Escherichia coli* (*E. coli)* analysis. Greywater was collected from a residential household of two adults and two children under the age of two years old.

Municipal tap water from College Station, Texas was obtained from a faucet in the greenhouse and used for watering as needed. Prior to each leaching, a sample of sourced irrigation water was collected for chemical analysis so that input chemistry for each constituent could be quantified and also because during storage the chemistry of the irrigation water might change. The average and standard deviation (n = 20 weeks) for each chemical constituent for each of the irrigation waters used in this experiment are shown in Table 1.

Table 1. Input irrigation water chemistry. All values are mg·L^{-1} unless shown otherwise. Values in parenthesis are 1 standard deviation.

Constituent	Rain	Tap	Bath	Wash
Conductivity (µS cm^{-1})	63.3	648	732	654
	(7.7)	(35)	(181)	(98)
Na^+	18.7	205.9	194.9	189.4
	(11.6)	(24.8)	(35.2)	(30.9)
K^+	1.0	3.0	6.3	4.3
	(0.8)	(2.6)	(5.0)	(1.0)
Mg^{2+}	0.4	0.4	0.5	0.4
	(0.1)	(0.1)	(0.3)	(0.1)
Ca^{2+}	6.0	3.0	2.3	1.9
	(1.7)	(0.6)	(1.1)	(0.6)
NH_4-N	0.07	0.03	5.6	1.6
	(0.09)	(0.02)	(10.5)	(1.2)
PO_4-P	0.03	0.2	0.5	0.1
	(0.02)	(0.1)	(1.0)	(0.2)
NO_3-N	0.8	0.2	0.2	0.1
	(0.4)	(0.1)	(0.1)	(0.1)
HCO_3^-	25.0	345.6	375.7	359.4
	(7.4)	(31.5)	(93.4)	(97.5)
DOC	7.0	1.0	14.1	45.5
	(4.0)	(0.4)	(19.4)	(16.9)

The method used for analyzing alkalinity in irrigation water reports the values as calcium carbonate. I used AqQA software (Rockware®) to determine the carbonate equilibrium for the average input irrigation treatments which was based on average pH and alkalinity values (Table 2).

Table 2. Carbonate equilibria for average input chemistry.

Irrigation Water	pH	CO_2 mmol kg^{-1}	HCO_3 mmol kg^{-1}	CO_3 mmol kg^{-1}
Harvested Rain	7.92	0.0016	0.3985	0.0016
Municipal Tap Water	8.44	0.04451	5.55	0.08729
Bath Water	8.81	0.02019	5.935	0.2207
Washing Machine Water	8.64	0.02906	5.736	0.1426

Table 3. Ingredients in products used in the grey water sources as listed in available MSDS sheets.

Irrigation water	Product	Listed ingredients on MSDS sheet
Washing Machine	Dreft	Ethyl alcohol
		Sodium borate
		2-Aminoethanol
		Biodegradable surfactants (anionic, cationic, nonionic)
		Enzymes
Washing Machine	Sun	Methyl ester sulfonate
		Cocomide DEA
		Anionic and nonionic surfactants
		Surfactants
		Ammonium salts
Bath	Huggies baby wash	C-H-S compounds

2.3 Leachate collection

The pots were irrigated every two or three days with 150 mL of their respective irrigation treatment to ensure they did not dry out thoroughly and maintained adequate moisture. A thorough leaching was done weekly by adding twice as much treatment (300 mL) to the pots.

Leachate was collected from each pot in 500 mL sterile whirlpak® bags and transported to the laboratory on ice for filtration and analysis. The treatments continued for five months (20 weeks) resulting in 620 samples for analysis.

2.4 Analysis of biomass carbon and nitrogen

Grasses were clipped approximately bi-weekly and the clipping weights were recorded and clippings returned to pots. At week numbers 4 and 20, sub-samples from each pot's clippings were oven-dried at 70 °C for 48 hrs and milled for carbon and nitrogen analysis (Perkin Elmer CHN analyzer).

2.5 Chemical analysis of irrigation water and treatment leachates

The pH and conductivity of each sample was recorded on each sample prior to filtration. Solutions were filtered using ashed (500° C for 4 hours) Whatman GF/F filters (nominal pore size 0.7 µm) and frozen until analysis.

Dissolved organic carbon (DOC) and total dissolved nitrogen (TDN) were measured with high temperature platinum-catalyzed combustion using a Shimadzu TOC-V_{CSH} and Shimadzu total measuring unit (TNM-1). Dissolved organic carbon was quantified as non-purgeable carbon using USEPA method 415.1 which entailed acidifying (2N HCl) the sample and sparging for 4 min with C-free air. Ammonium was analyzed using the phenate hypochlorite method with sodium nitroprusside enhancement (USEPA method 350.1) and nitrate was analyzed using Cd-

Cu reduction (USEPA method 353.3). Alkalinity was quantified using methyl orange (USEPA method 310.2) and was in the form of bicarbonate based on pH and calculation of the carbonate equilibrium (Table 2). Orthophosphate-P was quantified using the ammonium molybdate method (EPA 365.1). All colorimetric methods were performed with a Westco Scientific Smartchem Discrete Analyzer (Westco Scientific Instruments Inc. Brookfield, CT, USA). Dissolved organic nitrogen (DON) was calculated as the product of TDN – (NH_4-N + NO_3-N). A water blank, replicate sample, NIST traceable and check standard were run every 10th or 12th sample to monitor instrument precision. Coefficients of variance of replicates were less than 5% for TDN and DOC and less than 2% for the colorimetric methods during each analytical run otherwise the samples were re-analyzed.

2.6 *E. coli* quantification

Use of greywater supply for irrigation of turfgrass has implications of introducing *E. coli* into the environment which may potentially run-off to surface waters. Each new batch of input bath and washing machine water were analyzed for *E. coli* using a modified mTEC agar and the membrane filtration technique (USEPA method 1603). Briefly, irrigation water or leachate samples were filtered through a sterile 0.45 µm Millipore filter and incubated on modified mTEC agar for 2 hr at 35^{o} C and for 22-24 hr at 44.5^{o} C (USEPA, 2002). If *E. coli* counts in irrigation water sources exceeded 1000 colony forming units (CFUs)/100mL then leachate from the treatment pots irrigated with that water was also analyzed for *E. coli*.

2.7 Retention and release of nutrients

The net retention or release of chemical constituents over the course of the experiments was calculated by deducting the summed output from summed input (Eq. 2). Volumes of input (irrigant) and output (leachate) solution were recorded. I made the assumption that the type of irrigation water had no effect on nutrient cycling if there was a net retention of chemical constituents in the soil/plant unit and that a disruption of nutrient cycling had occurred by an excessive loss of nutrients in leachate.

Equation 2 $$\mathbf{RE = X(i) - X(o)}$$

where: RE is retention or release of nutrient, X(i) is nutrient mass input and X(o) is nutrient mass output in $g{\cdot}m^{-2}$.

2.8 Microbial community composition

At the end of the experimentation period, topsoil layers were sampled and differences in microbial community composition were determined using whole-soil fatty acid methyl ester analysis (FAME). Analysis of whole-soil FAME profiles were used in order to detect changes in microbial communities in the different irrigation treatments based on the lipid composition of microbial membranes (Cavigelli et al., 1995). Extraction of lipids and saponification was performed by adding 15 ml of 0.2 M KOH dissolved in methanol to the samples and heating at 37 °C for 1 h. Samples were vortexed for 20 s every 20 min. Extraction mixtures were neutralized with glacial acetic acid. Next 3 ml of hexane were added to each sample (vortexed for10 s). Extracts were centrifuged at 1000 x g-force, at 4 °C for 20 min and the organic phase was separated with a Pasteur pipette into a clean ashed glass tube. Hexane was evaporated almost to dryness under nitrogen gas and then transferred to labeled vials which were stored at -

20 °C. I shipped my extracted samples to the University of Delaware Plant and Soil Sciences Department for analysis. An Agilent model 6890 gas chromatograph with flame ionization detector (Agilent, Wilmington, DE) was used to quantify lipids and fatty acids. Briefly, two microliters of each sample were injected into a Hewlett Packard (Agilent) Ultra 2 (Crosslinked 5% Phenyl methyl silicone) column 25 m x 0.20 mm x 0.33 μm with a 100:1 split ratio and flow rate of 0.6 mL min^{-1} using hydrogen as the carrier gas. The injection temperature was 250°C, and the detection temperature was 300°C. The initial oven temperature was 170°C (hold for 0.0 min) and ramped at 5°C min^{-1} to a final temperature of 300°C, for a total run time of 12.0 min. Peaks were named using Sherlock Eukary program (MIDI, Inc., Newark, DE).

The fatty acids present can give an indication of the gram-negative, gram-positive, fungi and protozoa present in the sample. Fatty acids used to indicate each group of Gram-negative; (16:1 w7c; 16:1 w5c; 19:0 cyclo c11-12), Gram-positive (15:0 ISO; 16:0; ISO 17:1 G; 19:2 w6c), total bacteria (the sum of Gram-negative and Gram-positive bacteria plus 18:0), and fungi (18:2 w6c; 18:1 w9c), Protozoa (20:4w6c) (Gonzalez-Chavez et al. in review).

2.9 Statistical analysis

A univariate analysis of variance with two factors was applied to the data to determine if there was a significant effect of fertilization, irrigation or an interaction between fertilization and irrigation on 1) leachate chemistry, 2) net retention and release chemistry, 3) soil carbon and nitrogen, 4) foliar carbon and nitrogen and 5) biomass and biomass-N. Fertilization and an interaction between fertilization and irrigation source water only had a significant effect on leachate orthophosphate-P, so I performed a one-way analysis of variance (ANOVA) with post hoc Tukey (HSD) tests on the combined fertilized and unfertilized treatments for all irrigation treatments to test the hypotheses that irrigation source did not significantly affect 1) nutrient leachate fluxes and 2) net retention and release of nutrients. One way analysis of variance with a post hoc Tukey HSD test was also applied to the soil and foliage data.

FAME data were examined by principal component analysis (PCA) using a cross-products matrix (variance/covariance) (PC ORD5 version 5.0; MJM, Oregon) and then calculating scores for FAME markers by distance-based biplot. Fatty acids that were sporadically detected (i.e. did not occur in each treatment replicate) were removed from analysis to prevent undue influence (Bossio and Scow, 1998).

3. RESULTS

3.1 Leachate chemistry

A repeated measures univariate mixed model of analysis of variance was applied to the leachate and retention and release data to determine if there was a significant effect of fertilization, irrigation treatment or an interaction between fertilization and irrigation. Fertilization and an interaction between fertilization and irrigation were only apparent for the leachate orthophosphate-P (Table 4) and there was no fertilization effect on the summed release or retention data (Table 5). Following this analysis I applied one-way analysis of variance (ANOVA) with a post hoc Tukey HSD test on each leachate in turn.

My null hypothesis (HO-1) was rejected in part. Fertilization had no significant effect on leachate chemistry with the exception of leachate orthophosphate-P. My alternative hypotheses (H1) that fertilization would affect leachate nitrogen and orthophosphate was accepted for orthophosphate-P but not for any of the nitrogen species; and my alternative hypothesis (H2) that there would be a significant effect of grey water use for irrigation due to increased P in those waters was also accepted. My hypothesis, (H3) that there would be an interaction between fertilization and irrigation was accepted in part when I found an interaction for orthophosphate-P in greywater leachate.

Leachate pH and conductivity were significantly different among irrigation treatments ($p < 0.001$). The blanks and harvested rain treatments had significantly lower pH and conductivity than the domestic tap, bath and washing machine water treatments (Figures 4A and 4B). There was no significant difference among the tap, bath and washing machine treatments for pH, but the conductivity was significantly higher in the bath and washing machine irrigated treatments compared to the harvested rain irrigated and tap water irrigated treatments (Figure 4B). Leachate dissolved organic carbon was significantly greater in the grey water treatments compared to the tap water and harvested rain water irrigated treatments (Figure 5A). Leachate bicarbonate was significantly greater in the grey water treatments compared to the tap water and harvested rain water irrigated treatments (Figure 5B). The harvested rain irrigated treatments released significantly lower DOC and bicarbonate than the other treatments (Figures 5A and 5B). Fertilization and an interaction between fertilization and irrigation treatment was found for leachate orthophosphate-P (Table 4; Figure 6), this was however only evident in the fertilized bath treatment (Figure 6). Nitrogen species in leachate were also significantly affected by the type of irrigation treatment (Table 4; Figures 7 A, B and C). Nitrate-N, ammonium-N and dissolved organic nitrogen were all significantly higher in the treatments irrigated with bath water compared to the other irrigation treatments (Figure 7) with the exception of DON where the washing machine water irrigated treatment was not significantly different from the bath water irrigated treatment (Figure 7C).

Table 4. Effect of irrigation, fertilizer and interaction of irrigation*fertilizer on leachate chemistry. Values in bold indicate a significant effect of treatment at p < 0.05, those not bold indicate p > 0.05.

	pH	EC	DOC	NH_4-N	PO_4-P	HCO_3	NO_3-N	DON
Irrigation	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**
Fertilizer	0.64	0.13	0.96	0.79	**0.001**	0.71	0.49	0.37
Fertilizer*Irrigation	**0.03**	0.39	0.84	0.68	**0.001**	0.69	0.84	0.76

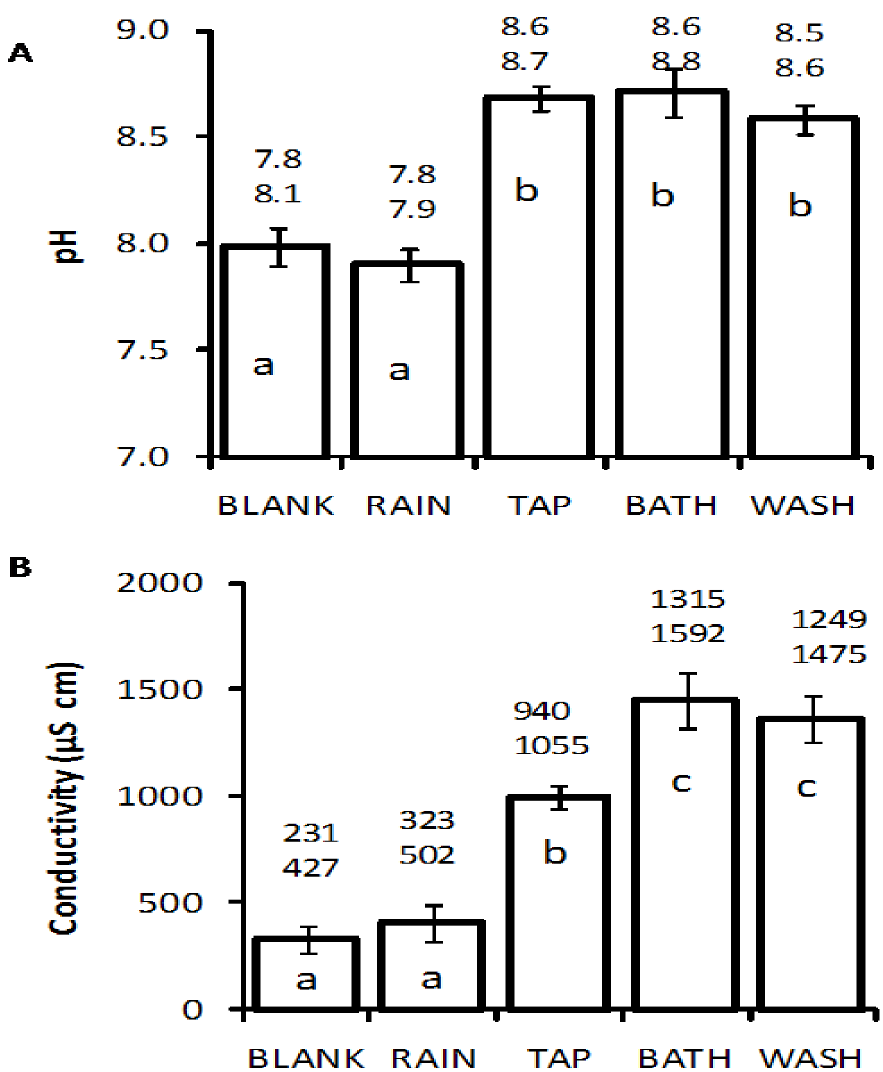

Figure 4. Average A) leachate pH and B) leachate conductivity for each of the irrigation treatments. Error bars are the standard deviation of replicates. Values above each bar represent the lower and upper 95% confidence interval. Differences in lower case letters indicate a significant difference among treatments at $p < 0.05$.

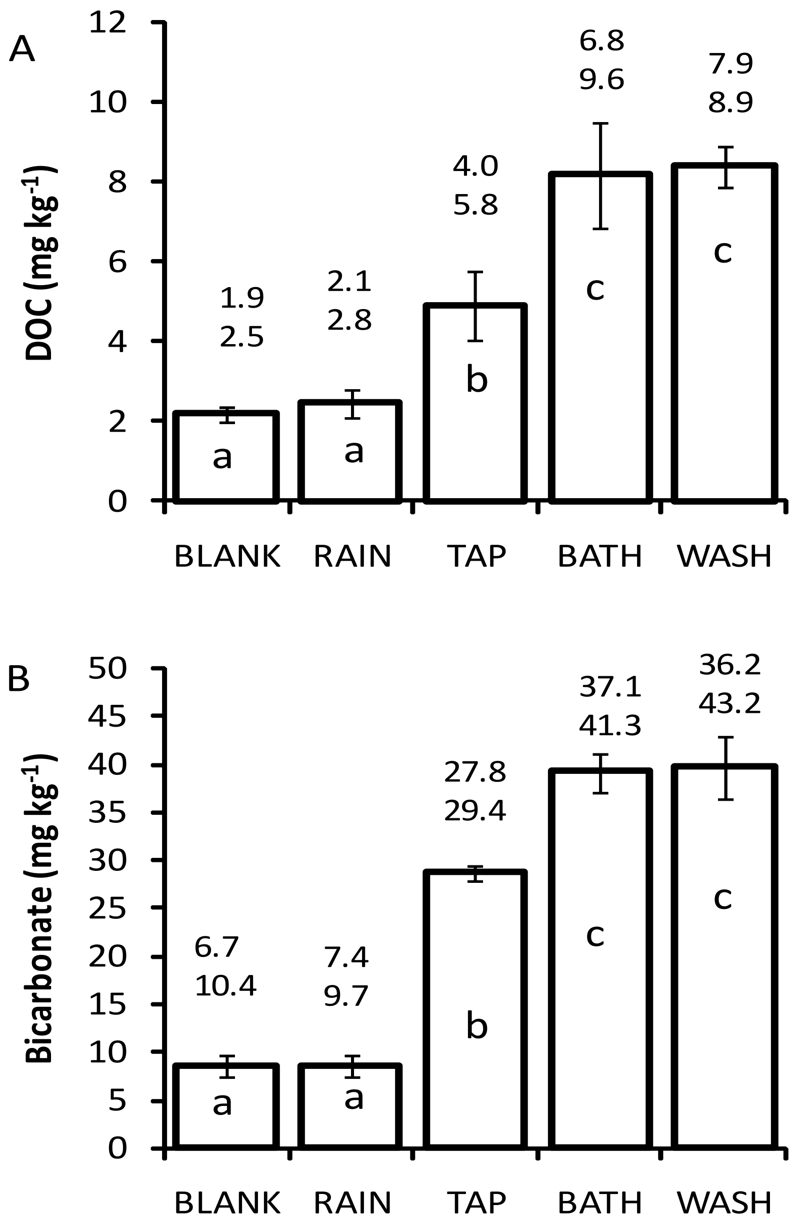

Figure 5. Average leachate A) dissolved organic carbon and B) bicarbonate among irrigation treatments. Error bars are the standard deviation of replicates. Values above each bar represent the lower and upper 95% confidence interval. Differences in lower case letters indicate a significant difference among treatments at $p < 0.05$.

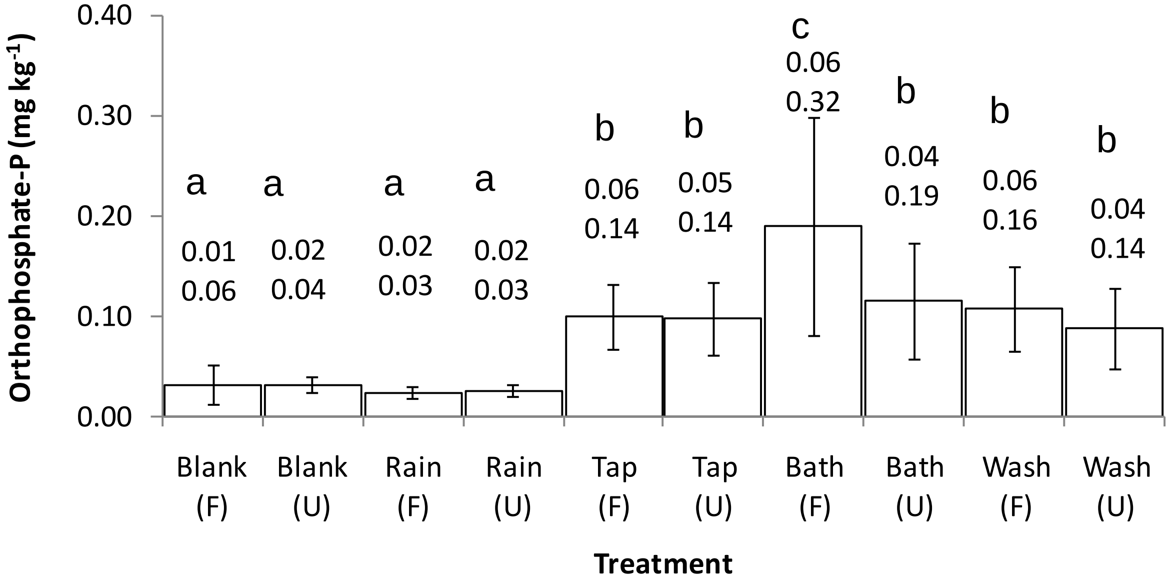

Figure 6. Average leachate orthophosphate-P among irrigation treatments. Different letters indicate significant difference (p < 0.05 Tukeys HSD post-hoc test). Error bars are standard deviation of the mean of replicate values. (U) is unfertilized treatment and (F) is fertilized treatment. Values above each bar represent the lower and upper 95% confidence interval. Differences in lower case letters indicate a significant difference among treatments at p < 0.05.

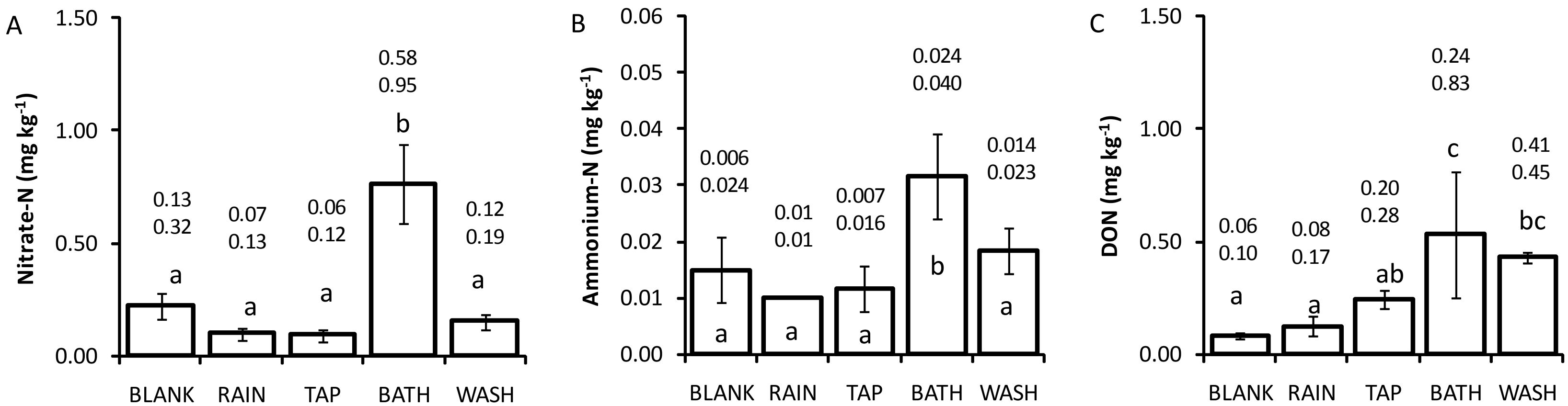

Figure 7. Average A) leachate nitrate-N, B) leachate ammonium-N and C) dissolved organic nitrogen among irrigation treatments. Error bars are the standard deviation of replicates. Values above each bar represent the lower and upper 95% confidence interval. Differences in lower case letters indicate a significant difference among treatments at p < 0.05.

3.2 Time series of leachate chemistries

I examined the irrigation water input and output leachate chemistries over time to determine whether any irrigation treatment showed a trend of increasing or decreasing in leachate chemistry over the five month irrigation period.

3.2.1 Dissolved organic carbon

Initially leachate DOC flux in the blanks and harvested rain irrigated treatment was higher than the input DOC but by week 16 leachate DOC flux was relatively steady at around 1.5 $\mu g \cdot g^{-1}$ (Figures 8 and 9). The leachate DOC in the domestic tap water irrigated treatment was much higher than the input DOC and ranged from 3-7 $\mu g \cdot g^{-1}$ showing a trend of increasing over the course of the experiment (Figure 10). As input DOC increased in the bath water irrigated treatment DOC output decreased (Figure 11). There was a peak in bath water DOC input at week 8. Input DOC was high in the washing machine water during the first nine weeks and leachate DOC flux was between 5 and 10$\mu g \cdot g^{-1}$ during that period. Input DOC reduced after week 11 and leachate DOC increased (Figure 12).

3.2.2 Orthophosphate-P

Orthophosphate-P input flux was lower than output leachate for all the treatments except for the bath water treatment (Figures 8-12). There was a large increase in orthophosphate-P input starting at week 8 through to week 12 in the bath water which led to an increase in output over the same period (Figure 11).

3.2.3 Bicarbonate

The harvested rain input bicarbonate peaked at around 10 $\mu g \cdot g^{-1}$ between weeks 6 and 10 and again between weeks 19 and 20 when there was a corresponding decrease in bicarbonate leachate in the blank treatment (Figure 8). Similarly as bicarbonate input decreased I observed an increase in leachate bicarbonate flux (Figure 8). Domestic tap water, bath water and washing machine input water were all high in bicarbonate (Figures 10 – 12) and leachate bicarbonate flux was lower in these irrigation treatments than input bicarbonate over the course of the experiment (Figures 10 – 12).

3.2.4 Dissolved organic nitrogen

Input and output DON was relatively similar in the blank and rain water harvested treatments with the exception of weeks 8 – 10 when DON input was four times higher than the other weeks (Figures 8 and 9). The domestic tap water DON input was low apart from a spike in DON input at week 6 (Figure 10). Throughout the course of the experiment leachate DON flux was higher than input DON flux with the exception of week 6 (Figure 10). Input DON in bath water was relatively low apart from a spike at weeks 9 – 12 which corresponded with peaks in nitrate-N and ammonium-N in bath water input (Figure 11). Input and output DON were relatively similar in the bathwater treatment with the exception of weeks 9 – 12 (Figure 11). Washing machine water input DON flux was extremely high at the start of the experimental period and reduced over the course of the experiment. Leachate DON flux in the washing machine water irrigated treatment was lower than input DON flux over the course of the experiment with the exception of week 19 when it was higher (Figure 12).

3.2.5 Nitrate-N

In the blank treatment, nitrate N input and output flux was similar except for extremely high outputs at weeks 1 to 3 (Figure 8). Otherwise as input nitrate-N increased, output nitrate-N decreased and as input nitrate-N decreased, output nitrate-N increased (Figure 8). Although the input nitrate-N was the same for the blank and harvested rain water treatments the outputs differed. The output of nitrate-N at weeks 1 to 3 was higher than for the remainder of the experiment but was about four-times lower than observed in the blank treatment (Figure 9). The output flux of nitrate-N after the first few weeks was typically lower than the input nitrate-N in the harvested rain water treatment (Figure 9). The tap water and washing machine nitrate-N outputs showed a similar pattern to the rain water harvested treatments; an initial flux of nitrate-N and then a relatively steady release (Figures 10 and 12). However where nitrate-N release was always higher than nitrate-N input in the washing machine water (Figure 12), inputs and outputs were similar in the domestic tap water irrigated treatments (Figure 10). The bath water treatment input had a similar peak to DON with a corresponding output (Figure 11).

3.2.6 Ammonium-N

Harvested rain water input ammonium-N displayed several peaks and troughs throughout the course of the experiment (Figures 8 and 9). Output ammonium-N flux was typically lower than input ammonium-N flux in the harvested rain water treatment (Figure 9) but showed an increase in flux in the blank treatments toward the end of the experiment (Figure 8). In the domestic tap water treatment there were evident peaks in ammonium-N input throughout the course of the experiment but output ammonium-N flux in the domestic tap water treatment remained fairly constant throughout the experimental period except at weeks 19 and 20 when there was a three-fold increase in ammonium-N in leachate (Figure 10). Washing machine water input also showed peaks in ammonium-N flux throughout the course of the experiment but the leachate flux remained low and relatively constant (Figure 12). A similar peak in input ammonium-N for the bath water treatment observed in nitrate-N and DON was apparent, otherwise ammonium-N input and output remain relatively constant (Figure 11).

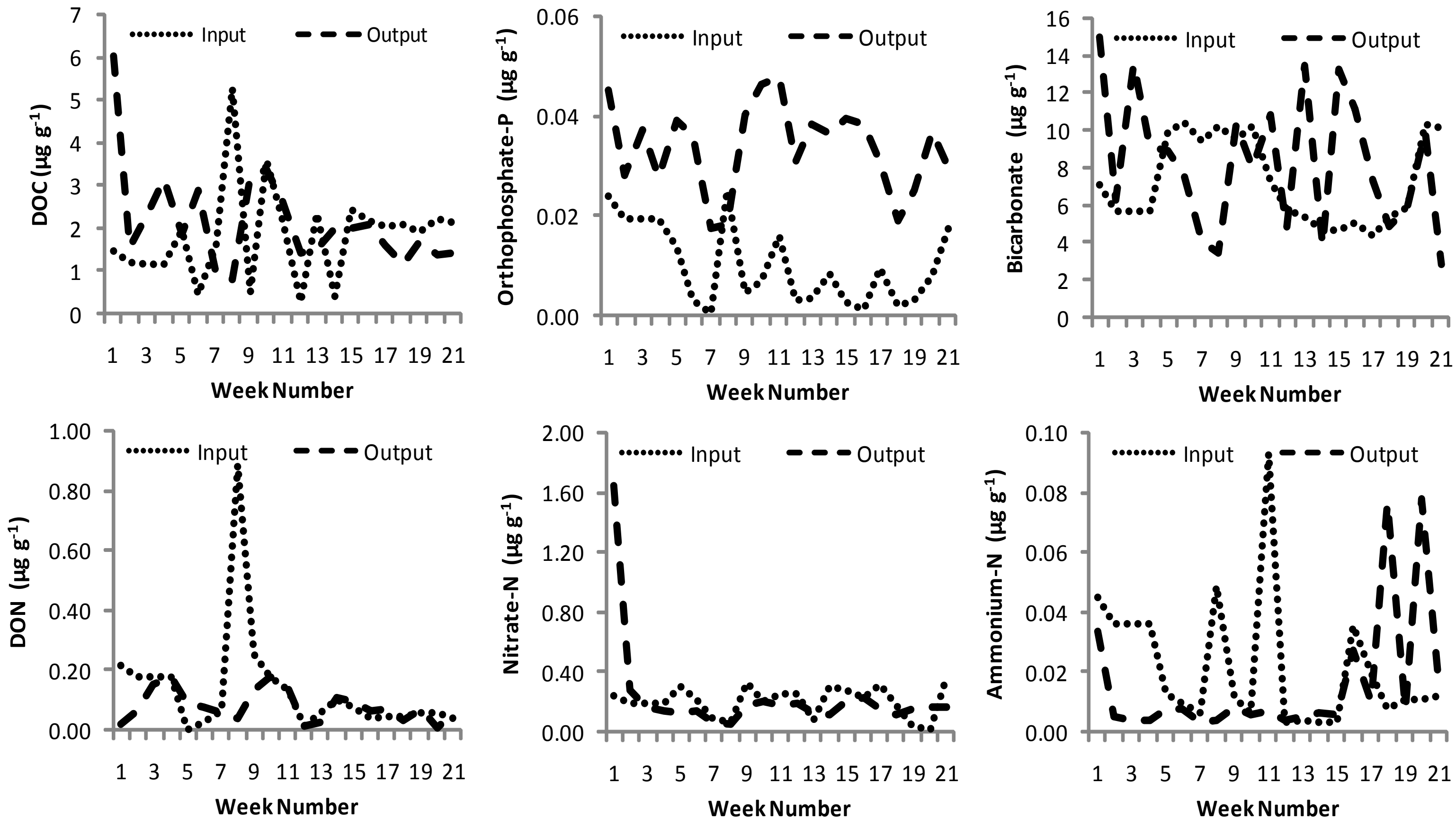

Figure 8. Input and output water chemistry for blank treatments (N = 3) during the 20 week study.

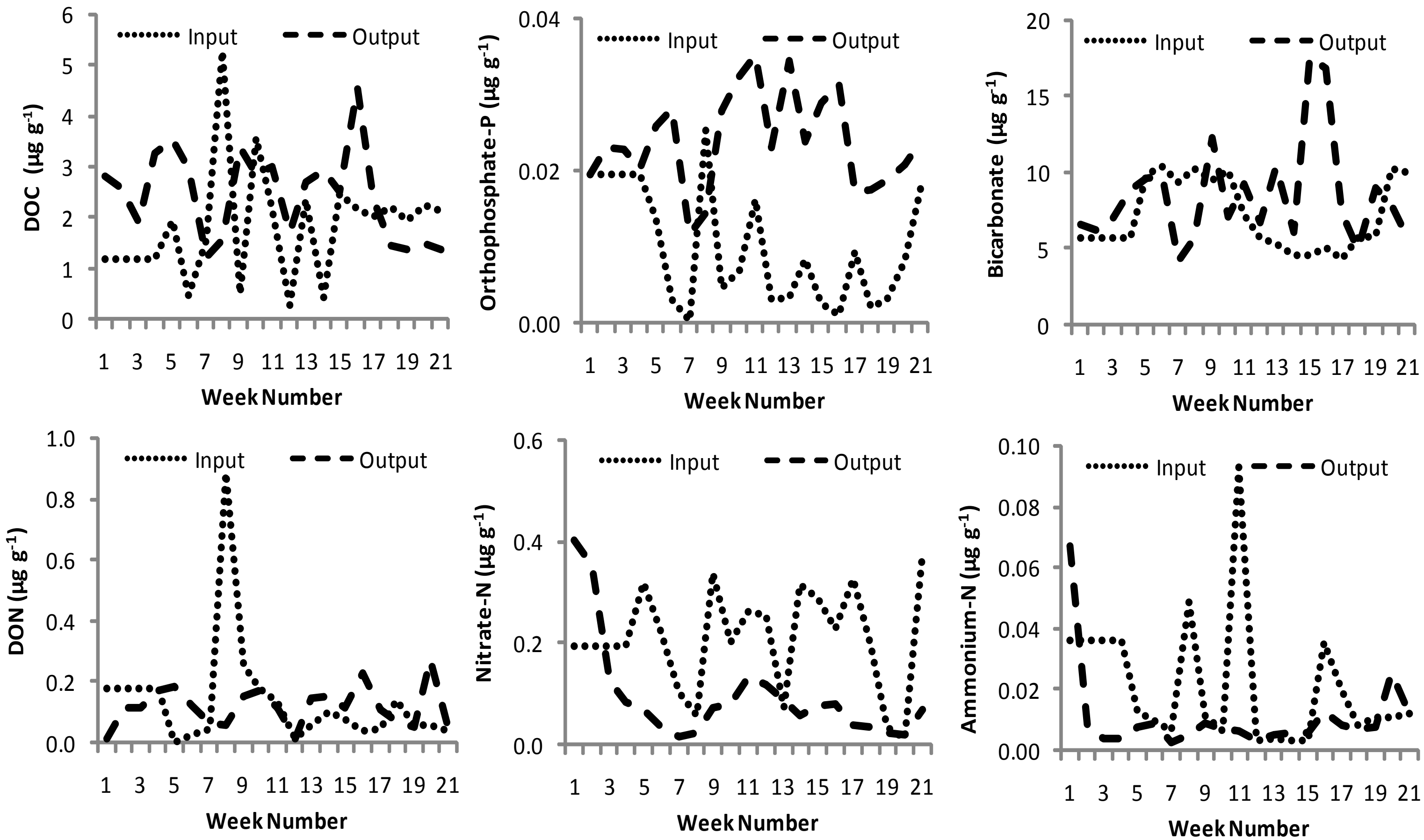

Figure 9. Input and output water chemistry for rain treatments (N = 3) during the 20 week study.

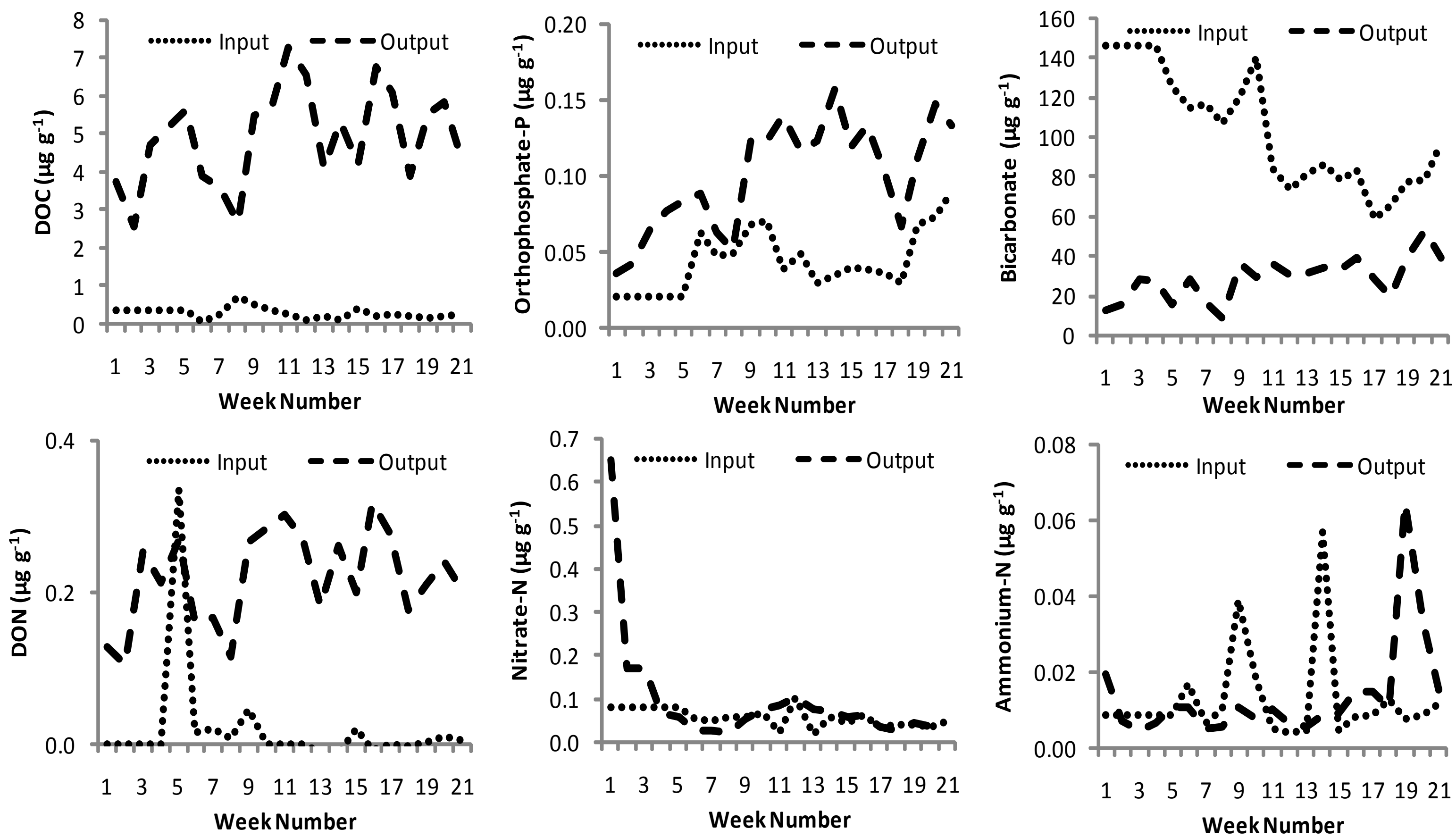

Figure 10. Input and output water chemistry for tap treatments (N = 3) during the 20 week study.

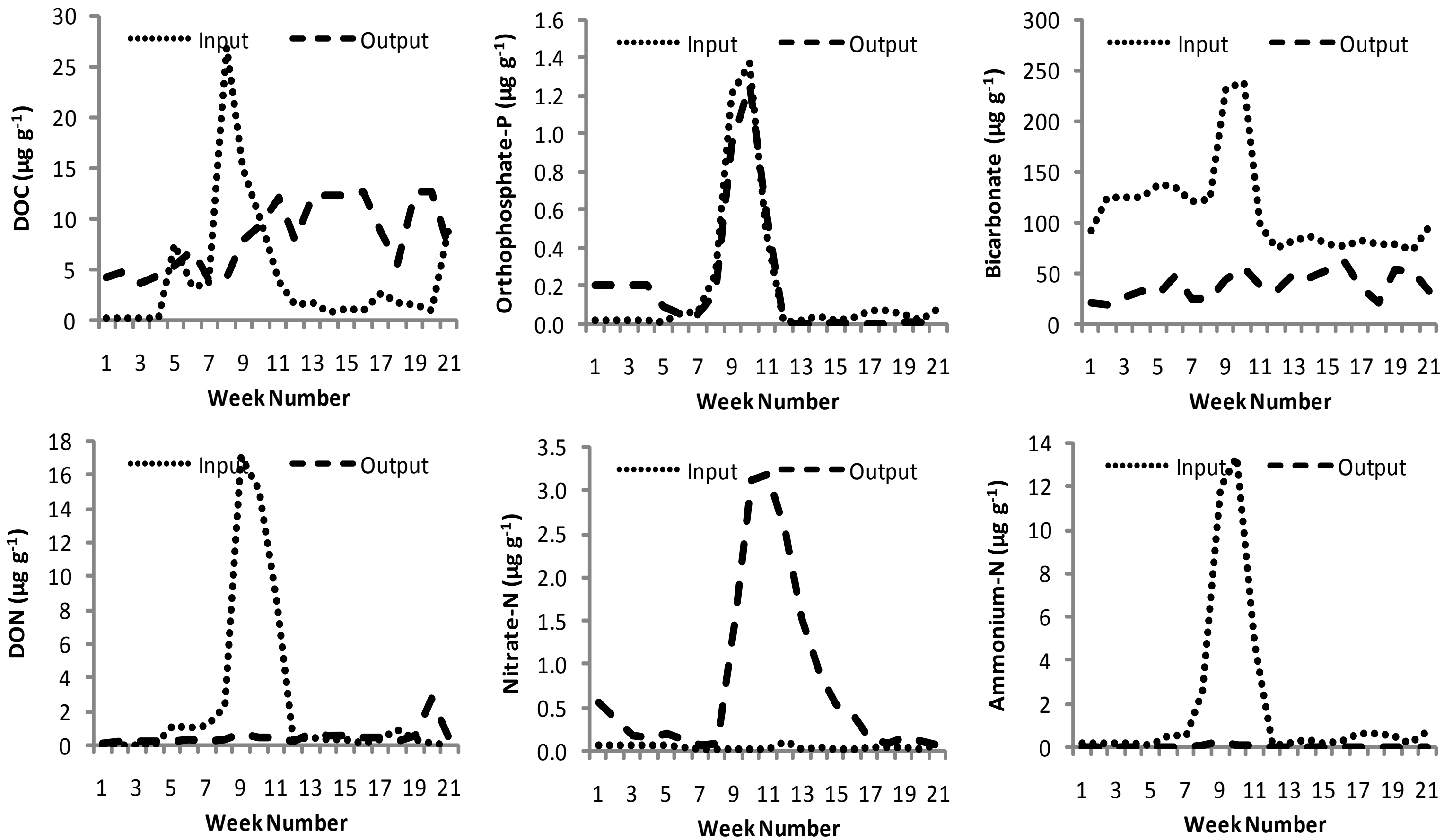

Figure 11. Input and output water chemistry for bath treatments (N = 3) during the 20 week study.

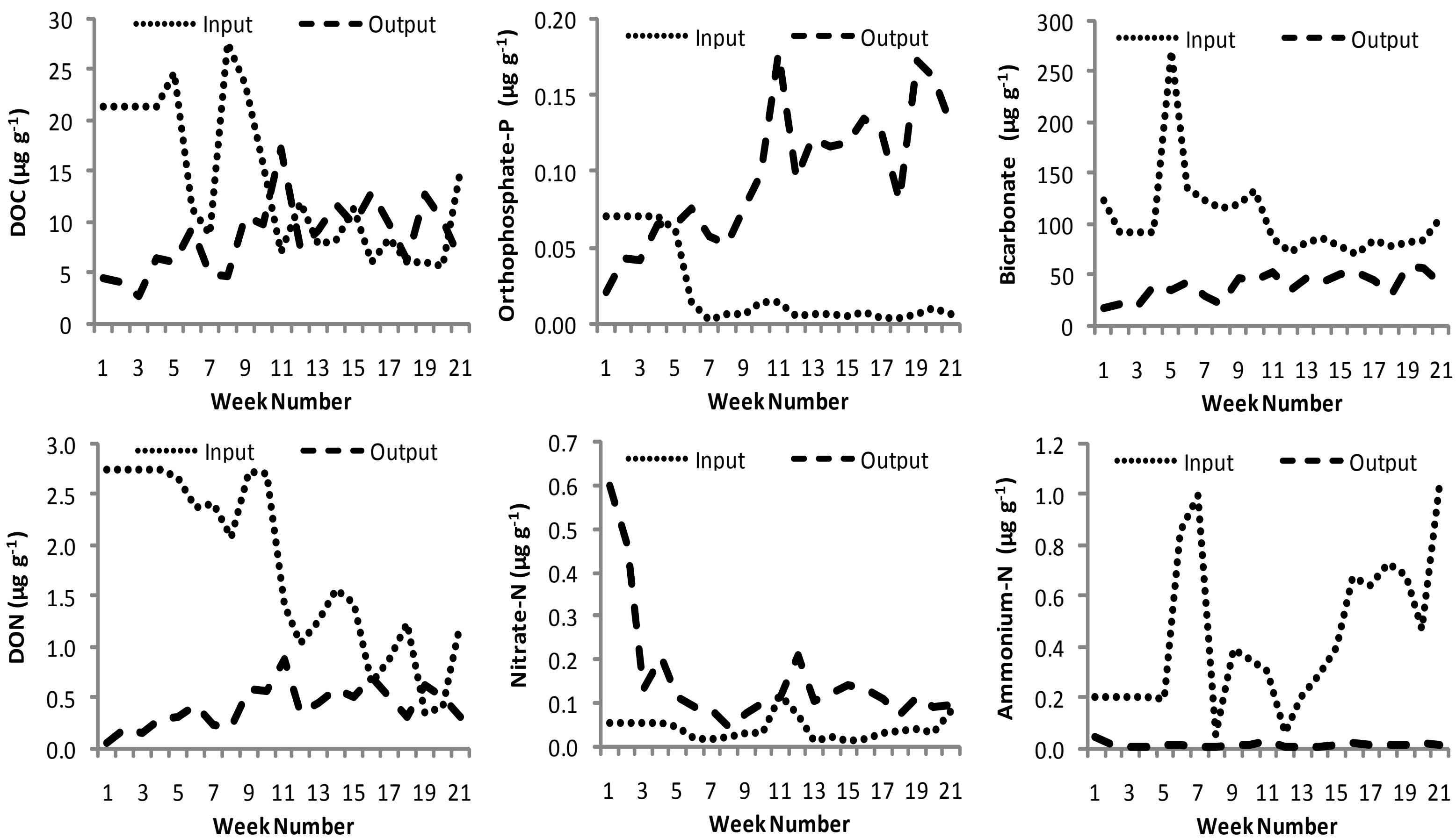

Figure 12. Input and output water chemistry for wash treatments (N = 3) during the 20 week study.

3.3 Net retention and release

Retention of carbon, nitrogen and orthophosphate in a soil is important for carbon sequestration and general nutrient cycling. I determined retention or release by deducting the sum of output chemistry from the sum of input chemistry and normalizing to area. Positive values are considered net retention and negative values are net releases over the five month irrigation period. Retention was considered to be 1) plant uptake, 2) soil adsorption, 3) retention of the ion in pore water at field capacity or 4) a combination of plant uptake, soil adsorption and nutrient contained in soil pore water. There was no effect of fertilization or an interaction between fertilization and irrigation on retention or release of chemical constituents (Table 5). Irrigation did however have a significant effect on retention and release on all nutrients and carbon compounds (Table 5).

Table 5. Effect of irrigation, fertilizer and interaction of irrigation*fertilizer on leachate release or retention. Statistical analysis was performed using a univariate analysis of variance with two factors. Italicized values in bold indicate a significant effect of treatment at $p < 0.05$ and not bold indicate no treatment effect at $p > 0.05$.

	DOC	NH_4-N	PO_4-P	HCO_3	NO_3-N	DON
Irrigation	***0.001***	***0.001***	***0.001***	***0.001***	***0.001***	***0.001***
Fertilizer	0.95	0.99	0.16	0.97	0.54	0.83
Fertilizer*Irrigation	0.99	1	0.19	0.99	0.83	0.99

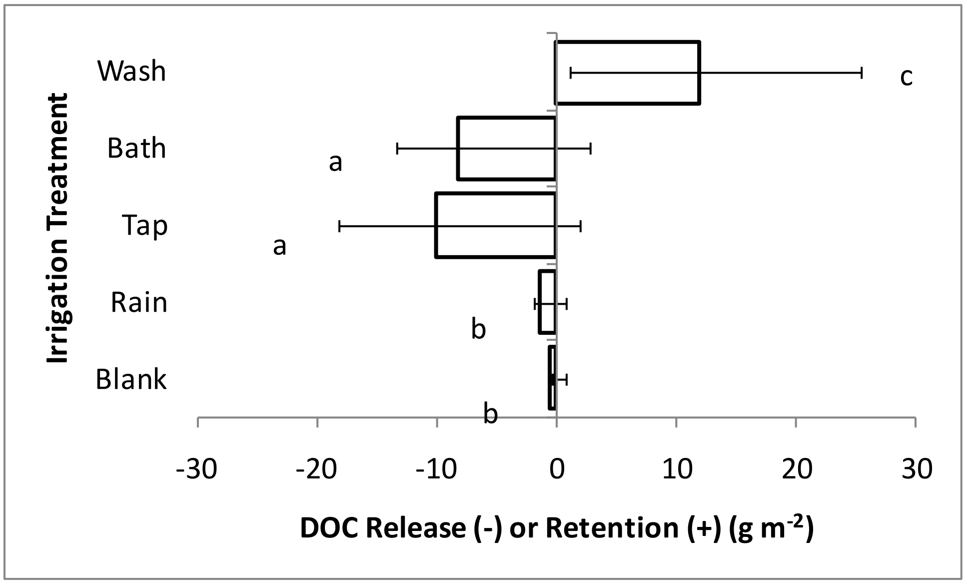

Figure 13. Release (-) or retention (+) of dissolved organic carbon based on the sum of input minus the sum of output DOC. Error bars are 95% confidence intervals for the mean value of three replicates. Different letters indicate a significant difference at $p < 0.05$.

One way analysis of variance on the combined fertilization treatment for all irrigation treatments determined there was a significant difference in retention and release among irrigation treatments ($p < 0.001$). Dissolved organic carbon showed a net release from the soil in all treatments (i.e. total output was greater than total input) with the exception of the treatments irrigated with washing machine water (Figure 13). The release of DOC from turfgrass irrigated with harvested rain water was significantly lower than the release of DOC from turfgrass irrigated with domestic tap water and bath water. Irrigating with washing machine water resulted in a net retention of DOC in the soils (Figure 13).

There was a significant difference in the retention or release of DON among treatments (ANOVA $p < 0.001$). Dissolved organic nitrogen displayed a net retention in all treatments with the exception of the domestic tap water treatment (Figure 14). There was no significant difference in DON retained or released in the rain or domestic tap water irrigated turfgrass neither was there a significant difference in retention or release of DON between the blank and rain treatment (Figure 14). The grey water treatments retained significantly more DON than the other treatments.

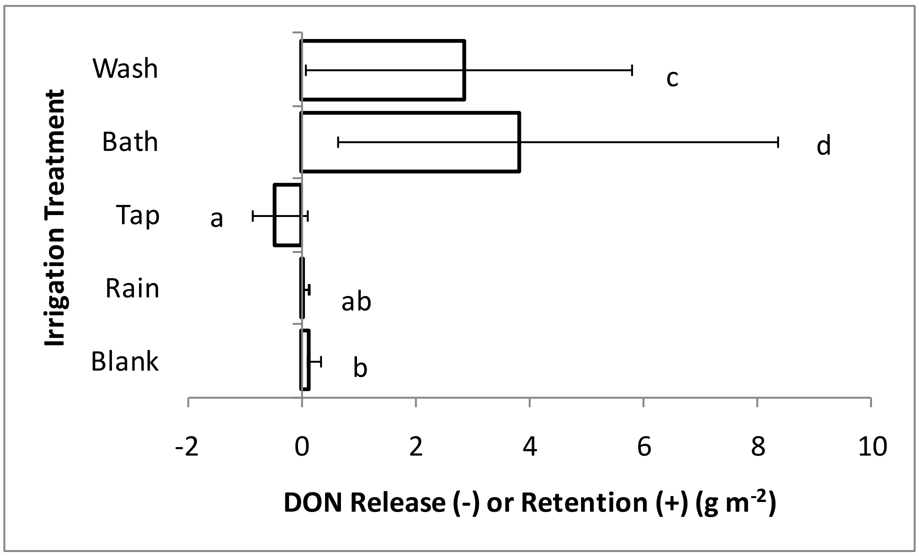

Figure 14. Release (-) or retention (+) of dissolved organic nitrogen based on the sum of input minus the sum of output DON. Error bars are 95% confidence intervals for mean value of three replicate. Different letters indicate significant difference among treatments.

Nitrate is typically thought of as a conservative ion and one that is typically leached rather retained in the soil. Relatively tight cycling of nitrate-N was observed with releases or retention approximately -0.5 to 0.5 g·m^2 for all treatments with the exception of the bath water irrigation treatments which had a significantly higher release. The harvested rain irrigated treatments, including blanks, showed a net retention of nitrate-N (Figure 15).

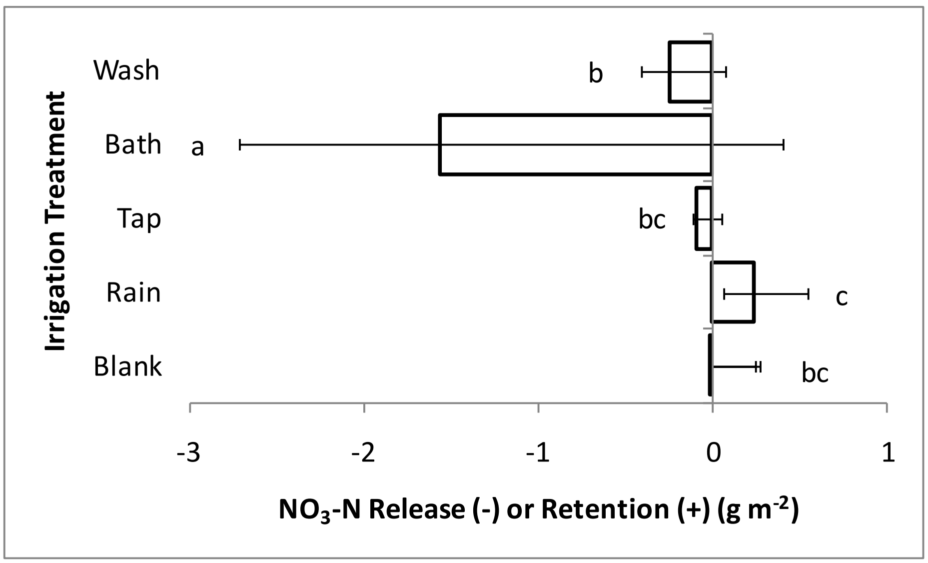

Figure 15. Release (-) or retention (+) of nitrate-N based on the sum of input minus the sum of output NO_3-N. Error bars are 95% confidence intervals for mean value. of three replicates. Different letters indicate significant difference among treatments.

Ammonium-N was retained in all treatments (Figure 16). The grey water (bath) retained significantly more ammonium-N than the other treatments and the grey water (washing machine) irrigated turfgrass retained significantly higher ammonium-N than the domestic tap water and rain irrigated treatments (Figure 16).

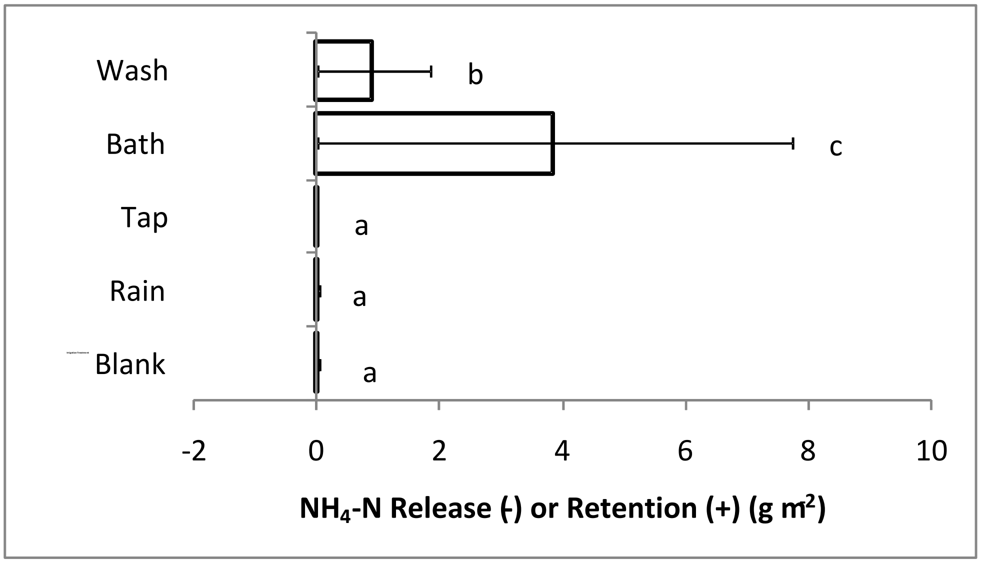

Figure 16. Release or retention of ammonium-N based on the sum of input minus the sum of output NH_4-N. Error bars are 95% confidence intervals for mean value of three replicates. Different letters indicate significant difference among treatments.

Orthophosphate-P was released by all treatments with the exception of the bathwater irrigated treatment. Significantly higher orthophosphate-P release occurred from the washing machine water irrigated turfgrass compared to turfgrass irrigated with harvested rain water and the blank (Figure 17). Bicarbonate was tightly cycled in the harvested rain treatments but was strongly retained in the domestic tap and grey water treatments (Figure 18).

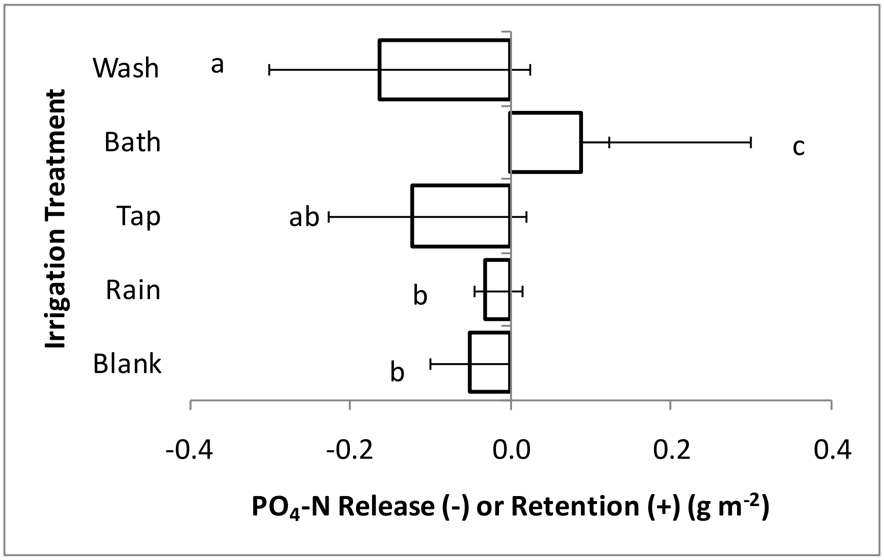

Figure 17. Release (-) or retention (+) of orthophosphate-P based on the sum of input minus the sum of output PO_4-P. Error bars are 95% confidence intervals for mean value. Different letters indicate significant difference among treatments.

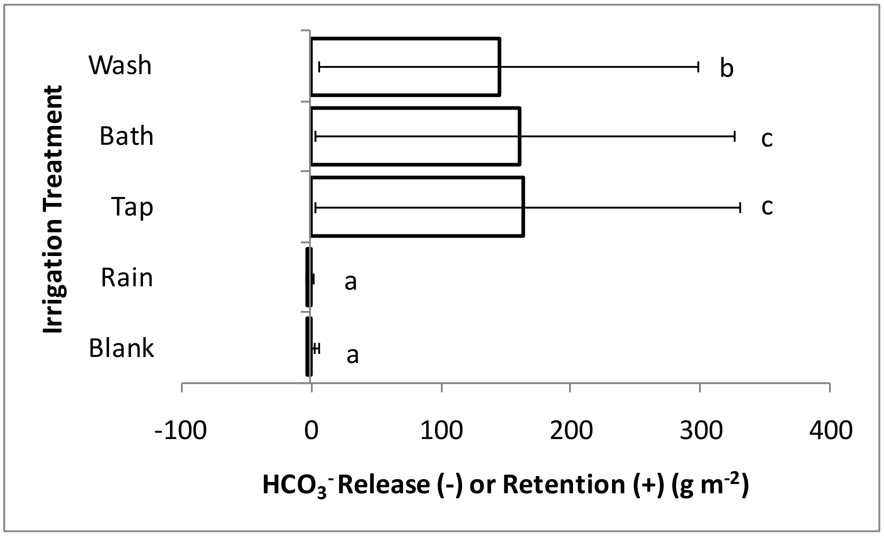

Figure 18. Release (-) or retention (+) of bicarbonate based on the sum of input minus the sum of output HCO_3^-. Error bars are 95% confidence intervals for mean value. Different letters indicate significant difference among treatments.

3.4 Biomass and biomass-N

To test my null hypothesis (HO-2) that fertilization and irrigation treatments would not have a significant effect on biomass or foliar carbon and nitrogen I applied a univariate analysis of variance with two factors (fertilization and irrigation). The analysis indicated that fertilization, irrigation and an interaction between fertilization and irrigation had a significant effect on the amount of biomass removed (Table 6) which I interpreted as growth rate and therefore on the amount of nitrogen returned to the pots in grass clippings at four weeks after irrigation treatment commenced (Table 7). By week 20 a univariate analysis of variance indicated that there was no significant effect of fertilization, irrigation or interaction between fertilization and irrigation on biomass removed or on the biomass-N returned to the pots (Table 6). I rejected my null hypothesis for an effect on biomass at week 4 and accepted it for week 20, thus my alternative hypotheses (H4- H6) were accepted for week 4 and rejected for week 20.

To assess the total biomass production over the course of the experiment I averaged the three replicates for each treatment for the periods the grass was clipped and then summed the values (Table 7). By deducting the %N at week 4 from the %N at week 20 I was able to calculate the increase in N over the period when grass was clipped but not analyzed for carbon and nitrogen. The percentage foliar N was estimated for each grass clipping period and biomass-N was estimated (Table 7).

Fertilization increased biomass-N by 22 and 24% in the domestic tap water and harvested rain water irrigated treatments respectively. In the bath and washing machine water irrigated treatments the increase in biomass-N in fertilized treatments compared to unfertilized treatments was 6 and 11% respectively.

Table 6. Significance of fertilization, irrigation and fertilization*irrigation on biomass production and biomass-N returned to the pots. Analysis was univariate analysis of variance with two factors. Italicized and bold values represent probability values where $p < 0.05$ there is a significant effect.

	Week 4		Week 20	
	Biomass	Biomass-N	Biomass	Biomass-N
Fertilizer	***< 0.001***	***< 0.001***	0.36	0.35
Irrigation	***0.026***	***0.022***	0.18	0.16
Fertilizer * Irrigation	***0.047***	***0.049***	0.29	0.3

Table 7. Sum of average treatment biomass and estimated biomass-N that was clipped and returned to pots over the course of the experiment.

	Biomass (g)	Nitrogen (g)
Rain (U)	15.32	2.37
Rain (F)	20.05	3.11
Tap (U)	14.69	2.28
Tap (F)	18.92	2.93
Bath (U)	25.81	4.00
Bath (F)	27.53	4.27
Wash (U)	19.1	2.96
Wash (F)	21.38	3.31

3.5 Foliar carbon and nitrogen

Fertilization had a significant effect on foliar carbon (2-tailed t-test; $p < 0.01$) but not on foliar nitrogen (2-tailed t-test; $p > 0.05$) at week 0 before the irrigation treatments commenced. At weeks 4 and 20, a univariate analysis of variance with two factors (fertilization and irrigation) was applied to the data. Fertilization had an effect on foliar nitrogen at week 20 only (Table 8). Irrigation treatment had an effect on foliar nitrogen and foliar C:N ratio at week 4 and on foliar carbon, nitrogen and the C:N ratio at week 20 (Table 8). Consequently I was able to reject my null hypotheses (HO-2) that there would be no significant effect of irrigation or fertilization on foliar C and N and accept my alternative hypotheses that there would be a significant effect of irrigation and fertilization on foliar C and N (H4-H5). There was no interaction effect on foliar carbon, nitrogen or C:N ratio throughout the course of the experiment which led me to reject my alternative hypothesis (H6) (Table 8).

Treatment significantly affected foliar nitrogen, foliar carbon and foliar carbon to nitrogen ratio (Figures 19-21). Foliar nitrogen increased for all treatments at 4 weeks and 20 weeks relative to foliar N before the irrigation treatments commenced (Figure 19). At week 4 there was a significant difference in foliar N among treatments with the fertilized washing machine irrigation treatment displaying significantly higher foliar N than the unfertilized tap, fertilized rain and unfertilized rain irrigation treatments (Figure 19). Fertilized turfgrass irrigated with grey water (bath and washing machine water) had significantly higher foliar nitrogen at week 20 compared to turfgrass irrigated with harvested rain water (Figure 19).

Foliar carbon increased at week 4 and week 20 after treatment commenced relative to foliar carbon before treatment commenced (t=0; Figure 20). At week 4 treatments did not have an effect on foliar C and there was no significant difference in foliar C among treatments. By week 20 there was a significant difference in foliar C among treatments with the fertilized harvested rain treatment having significantly lower foliar C than the fertilized and unfertilized grey water treatments (Figure 20).

Table 8. Effect of fertilization, irrigation and interaction of fertilization*irrigation on ryegrass foliage carbon and nitrogen before irrigation treatments started and at 4 and 20 weeks. Bold italicized values are significant effects at $p < 0.05$. na-no data.

Factor	Foliage Week 0			Foliage Week 4			Foliage Week 20		
	Carbon	Nitrogen	C:N	Carbon	Nitrogen	C:N	Carbon	Nitrogen	C:N
Fertilization	***0.002***	0.12	0.48	0.11	0.16	0.45	0.58	***0.049***	0.07
Irrigation	na	na	na	0.63	***0.001***	***0.002***	***<0.001***	***0.001***	***0.005***
Fertilizer*Irrigation	na	na	na	0.36	0.5	0.56	0.35	0.42	0.72

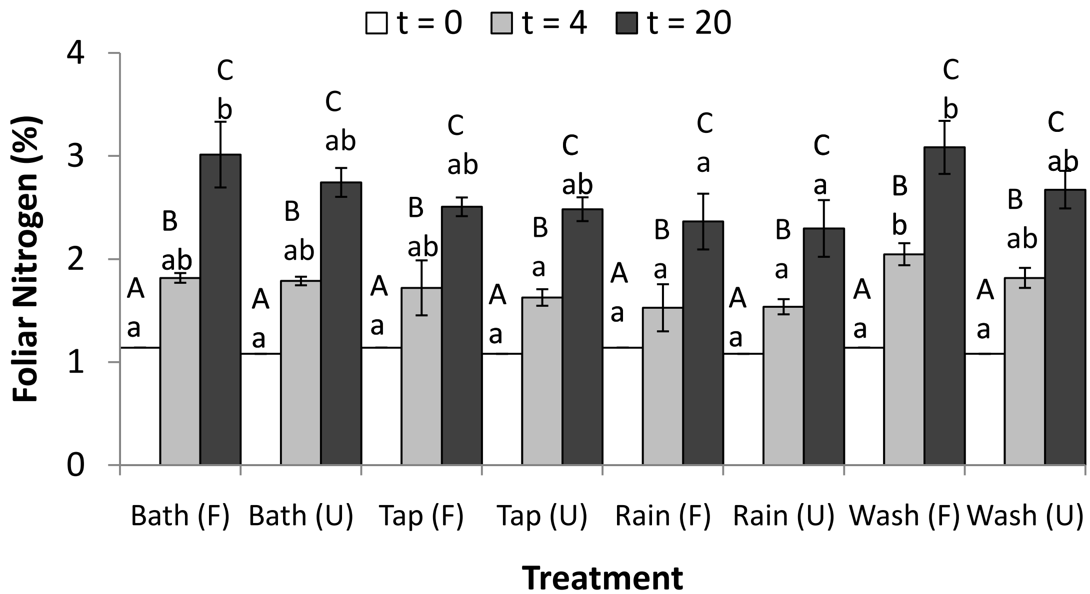

Figure 19. Average foliar nitrogen before treatment (t = 0), at 4 weeks (t = 4) and 20 weeks (t = 20) after treatment. Different lowercase letters indicate significant difference among treatments at each time unit (t) and different uppercase letters indicate significant difference within treatment (p < 0.05 Tukeys honestly significant difference post-hoc test).

Foliar carbon to nitrogen ratio decreased for all treatment over the five month irrigation period (Figure 21). The decrease in foliar C:N ratio was driven by a higher rate of increase in foliar N than foliar C. Within treatments, foliar C:N ratio was significantly reduced between week 0 and week 4 and between week 4 and week 20 for all treatments (Figure 21).

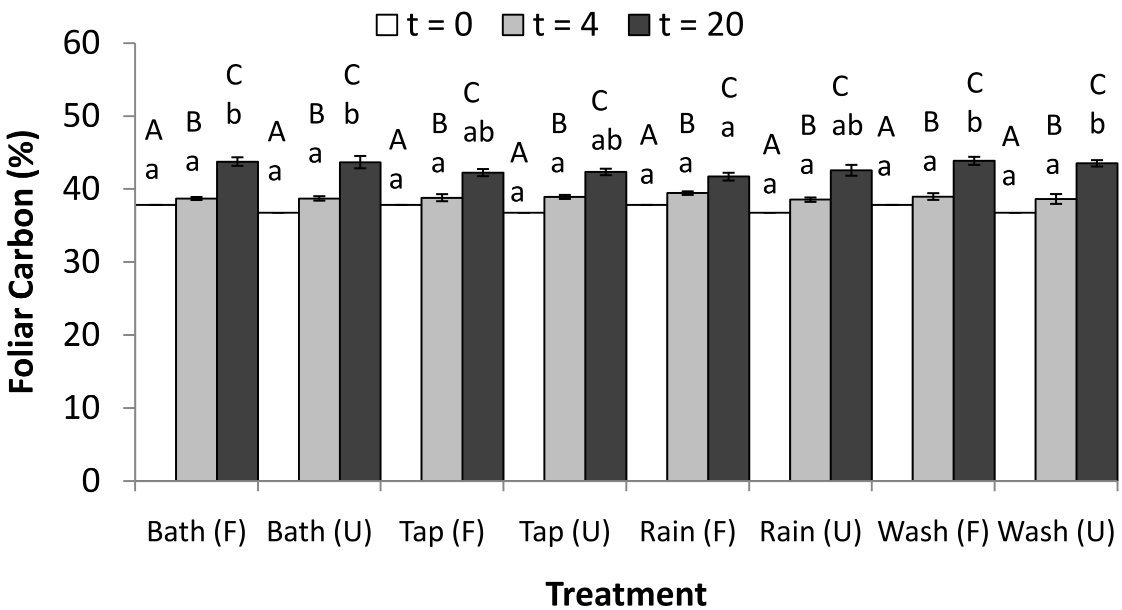

Figure 20. Average foliar carbon before treatment (t = 0), at 4 weeks (t = 4) and 20 weeks (t = 20) after treatment. Different lowercase letters indicate significant difference among treatments at each time unit (t) and different uppercase letters indicate significant difference within treatment (p < 0.05 Tukeys honestly significant difference post-hoc test).

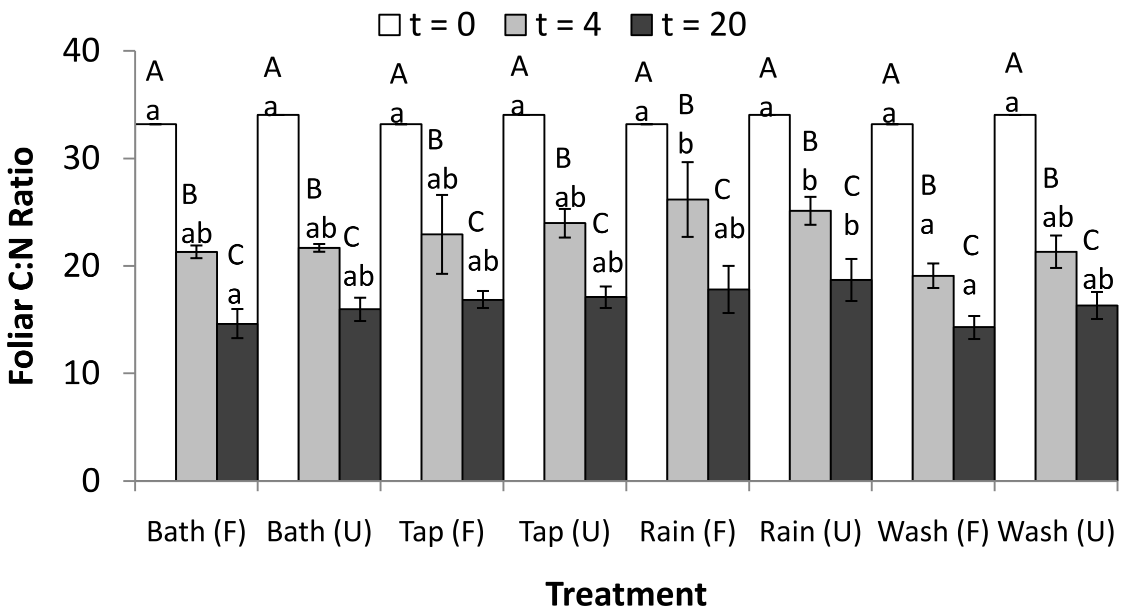

Figure 21. Average foliar C: N ratio before treatment, 4 wks and 20 wks after treatment. Different lowercase letters indicate significant difference among treatments at each time unit (t) (p < 0.05 Tukeys honestly significant difference post-hoc test).

To understand what constituents of irrigation water might be affecting foliar chemistry I examined the relationships between input chemistry and foliar C and N at 20 weeks using backward stepwise regression analysis to find a single chemical constituent that might be responsible for increases in foliar C and N. Sixty-nine percent of the variance in foliar nitrogen ($p = 0.01$) was explained by the DON in input water and the percentage of variance explained in foliar N was not improved greatly with the addition of other input chemical constituents. Dissolved organic nitrogen in irrigation water also explained a significant amount of the variance in foliar carbon and foliar C: N ratio (Figure 22).

Eighty-six percent of the variance in foliar carbon was explained by input irrigation DON ($p < 0.001$) and 63% of the variance in foliar C:N ratio was explained by input irrigation water DON ($p = 0.02$).

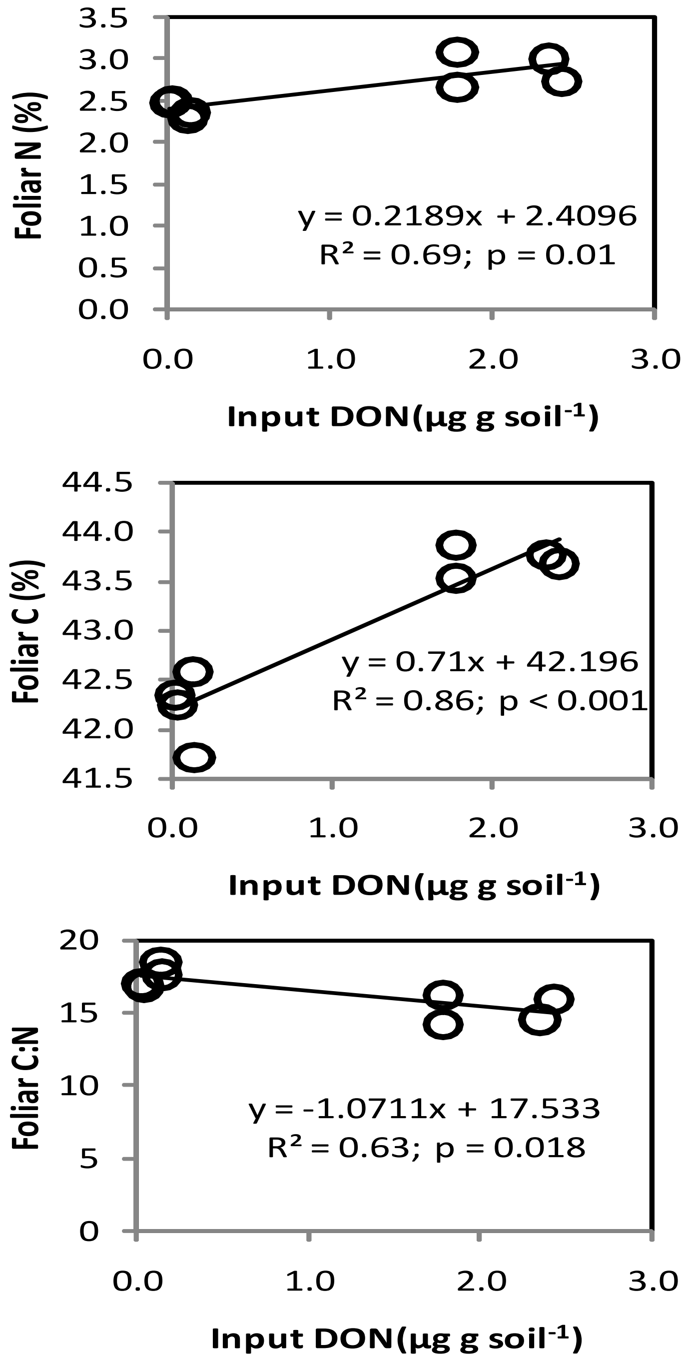

Figure 22. Relationships between foliar chemistry and input dissolved organic nitrogen in irrigation water.

3.6 Carbon and nitrogen in the topsoil and sand layers

A univariate analysis of variance with two factors (fertilization and irrigation) was performed on the topsoil and 0-5 and 5-9 cm sand layers to test my null hypothesis that fertilization and irrigation would have no significant effect on C and N in the topsoil or sand layers (HO-3). Application of a starter fertilizer had a significant effect on topsoil C:N ratio and nitrogen content in the 5-9 cm sand layer (Table 9). Irrigation treatment had a significant effect on the topsoil nitrogen and carbon content in the 0-5 cm sand layer and nitrogen content in the 5-9 cm sand layer (Table 9). There was an interaction between fertilization and irrigation treatment on nitrogen in the 5-9 cm sand layer only (Table 9). Based on this analysis I rejected my null hypothesis (HO-3) and accepted my alternative hypotheses (H7).

3.6.1 Topsoil

I then examined the effect of treatment and fertilization on the topsoil layer carbon, nitrogen and C:N ratio using analysis of variance at pre-treatment and 20 weeks. There was a significant reduction in the percentage of soil carbon in the topsoil layer in the fertilized blanks and fertilized pots irrigated with domestic tap water (Figure 23) but no significant difference in carbon in the other treatments relative to carbon in the topsoil material at the start of the experiment (Figure 23). Fertilization significantly reduced soil carbon in the blank and domestic tap water treatments compared to the harvested rain and grey water treatments (Figure 23).

Table 9. Significance of fertilization, irrigation and the interaction of fertilization and irrigation on topsoil and sand after 20 weeks of irrigation treatments. Bold, italicized values show a significant effect of the factor at $p < 0.05$.

Factor	Topsoil			0-5 cm Sand			5-9 cm Sand		
	Carbon	Nitrogen	C:N	Carbon	Nitrogen	C:N	Carbon	Nitrogen	C:N
Fertilization	0.09	0.17	***0.00***	0.6	0.61	0.58	0.29	< ***0.001***	0.56
Irrigation	0.48	***0.05***	0.18	***0.01***	0.36	0.59	0.61	< ***0.001***	0.52
Fertilizer*Irrigation	0.19	0.18	0.29	0.06	0.3	0.67	0.26	< ***0.001***	0.45

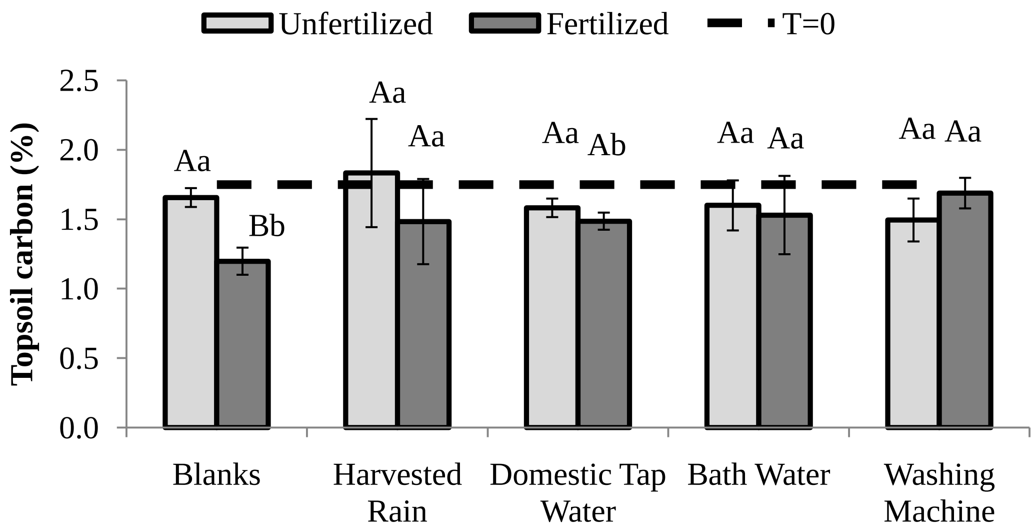

Figure 23. Percentage of carbon in the topsoil layer for each treatment at the end of the experiment. T=0 is the percentage of carbon before treatments commenced. Error bars are standard deviation. Blanks are pots with no vegetation and irrigated with harvested rain water. Different lowercase letters are significant difference ($p < 0.05$) between the treatment at T=0 and 20 weeks. Uppercase letters signify significant difference between fertilized and unfertilized treatment.

Compared to the nitrogen content in the topsoil before the experiment commenced both the unfertilized and fertilized blanks, the unfertilized harvest rain water treatment, and the fertilized domestic tap water and washing machine water irrigation treatments had significantly greater nitrogen (Figure 24). Using an initial fertilization at the beginning of the experimental period had no significant effect on nitrogen in the topsoil (Figure 24).

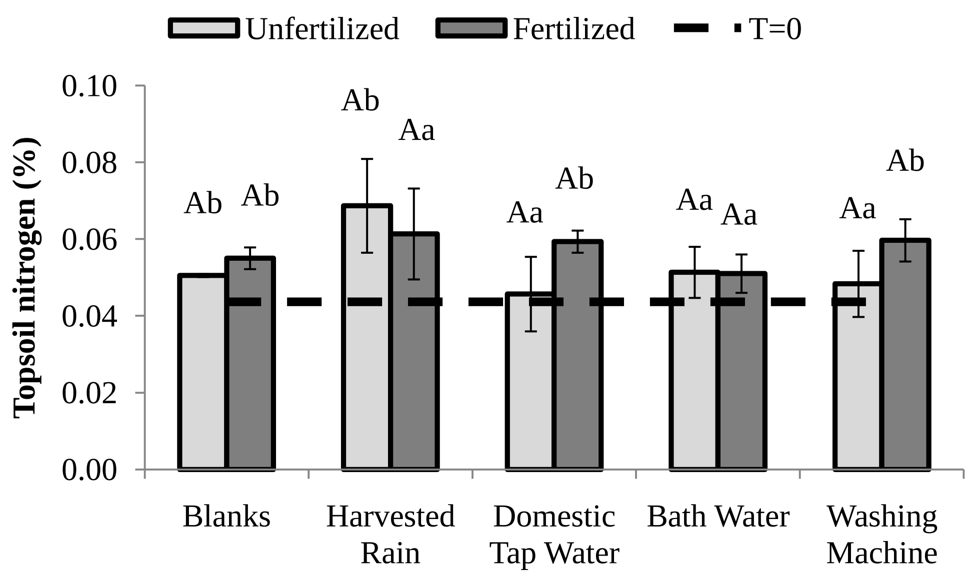

Figure 24. Percentage of nitrogen in the topsoil layer for each treatment at the end of the experiment. T=0 is the percentage of nitrogen in the topsoil before treatments commenced. Error bars are standard deviation. Blanks are pots with no vegetation and irrigated with harvested rain water. Different lowercase letters are significant difference ($p < 0.05$) between the treatment at T=0 and 20 weeks. Uppercase letters signify significant difference between fertilized and unfertilized treatment.

At the end of the experiment, the carbon: nitrogen ratio in the topsoil layer was significantly reduced relative to the topsoil C:N prior to initiation of irrigation treatments in all the fertilized treatments with the exception of the bath water (Figure 25). The C: N ratio was reduced in all the unfertilized treatments with the exception of domestic tap water and washing machine water (Figure 25). Initial fertilization had a significant effect on topsoil layer C:N in the blanks and the harvested rain water irrigation treatments only.

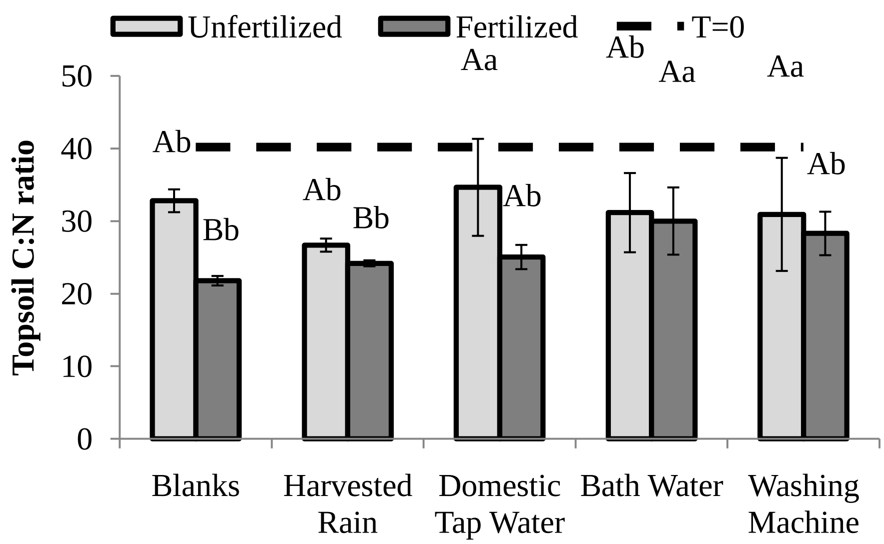

Figure 25. Carbon: Nitrogen ratio in the topsoil layer for each treatment at the end of the experiment. T=0 is the percentage of carbon in the topsoil before treatments commenced. Error bars are standard deviation. Blanks are pots with no vegetation and irrigated with harvested rain water. Different lowercase letters are significant difference ($p < 0.05$) between the treatment at T=0 and 20 weeks. Uppercase letters signify significant difference between fertilized and unfertilized treatment.

3.6.2 The 0-5 cm sand layer

Pre-treatment carbon was two orders of magnitude smaller in the sand compared to the topsoil. Soil N was undetectable in the pre-treatment sand, so I used the instrument detection limit for nitrogen to enable meaningful statistical analysis.

Soil carbon in the 0-5 cm sand layer was significantly reduced relative to the pre-treatment sand in the unfertilized blanks, harvested rain water irrigation treatments and in the fertilized blank. For the other irrigation treatments carbon did not differ significantly over the five month irrigation period (Figure 26). Fertilization significantly increased soil carbon in the blank and significantly reduced soil carbon in the tap water treatments (Figure 26).

Nitrogen in the 0-5 cm sand layer was not significantly different from the nitrogen in the sand at the start of the five month experimental period with the exception of the unfertilized blank and domestic tap water treatments which had significantly higher nitrogen (Figure 27). Within treatments fertilization did not significantly affect soil N in the 0-5 cm sand layer (Figure 27).

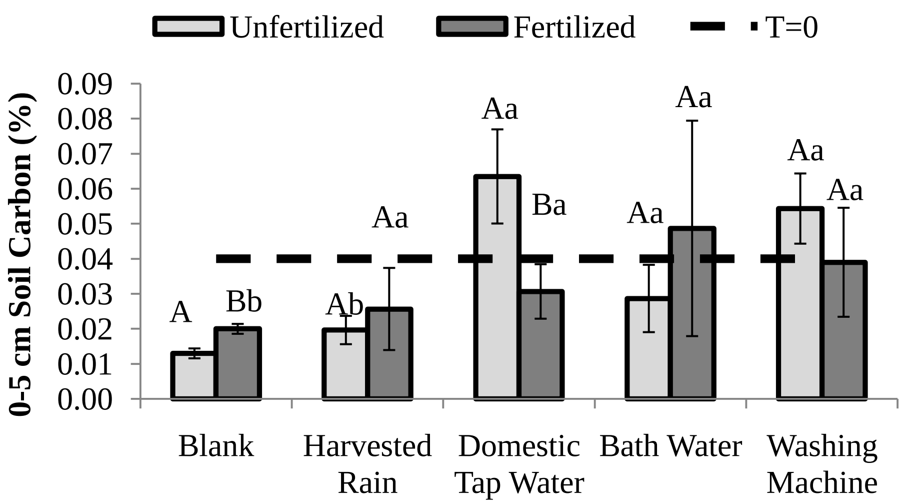

Figure 26. Percentage of carbon in the 0-5 cm sand layer for each treatment at the end of the experiment. T=0 is the percentage of carbon in the sand before treatments commenced. Error bars are standard deviation. Blanks are pots with no vegetation and irrigated with harvested rain water. Different lowercase letters are significant difference ($p < 0.05$) between the treatment at T=0 and at 20 weeks. Uppercase letters signify significant difference between fertilized and unfertilized treatment.

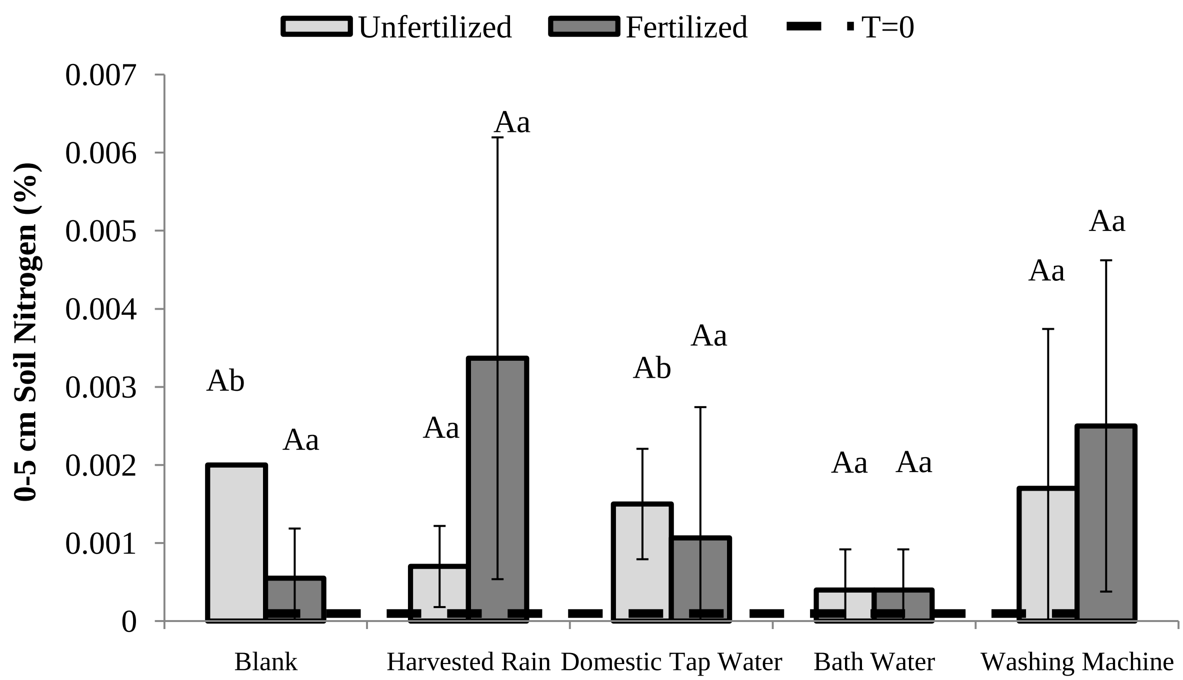

Figure 27. Percentage of nitrogen in the 0-5 cm sand layer for each treatment at the end of the 20 week experiment. T=0 is the percentage of nitrogen in the sand before treatments commenced. Error bars are standard deviation. Blanks are pots with no vegetation and irrigated with harvested rain water. Different lowercase letters are significant difference ($p < 0.05$) between the treatment at T=0 and at 20 weeks. Uppercase letters signify significant difference between fertilized and unfertilized treatment.

3.6.3 The 5-9 cm sand layer

In the 5-9 cm sand layer soil carbon was significantly reduced relative to the initial sand used for the experiment in all treatments with the exception of the unfertilized harvested rain water and domestic tap water treatments (Figure 28). Fertilization did not significantly affect soil C in the 5-9 cm sand layer within treatments (Figure 28).

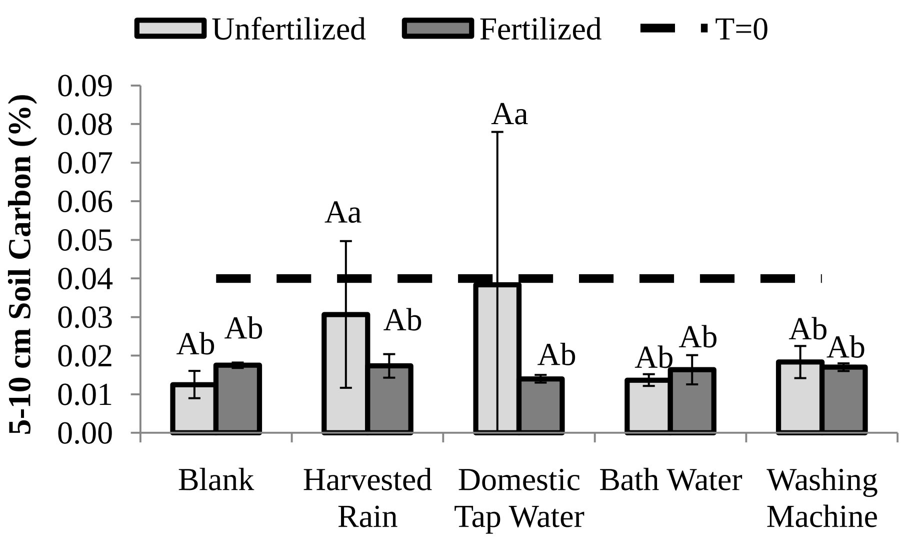

Figure 28. Percentage of carbon in the 5-9 cm sand layer for each treatment at the end of the experiment. T=0 is the percentage of carbon in the sand before treatments commenced. Error bars are standard deviation. Blanks are pots with no vegetation and irrigated with harvested rain water. Different lowercase letters are significant difference ($p < 0.05$) between the treatment at T=0 and at 20 weeks. Uppercase letters signify significant difference between fertilized and unfertilized treatment.

Soil N in the 5-9 cm sand layer was not significantly affected by any irrigation treatment with the exception of the unfertilized blank (Figure 29). Fertilization only had an effect on soil N in the blank treatments where the unfertilized blank had significantly higher soil N at 5-9 cm sand layer than the fertilized blank (Figure 29) .

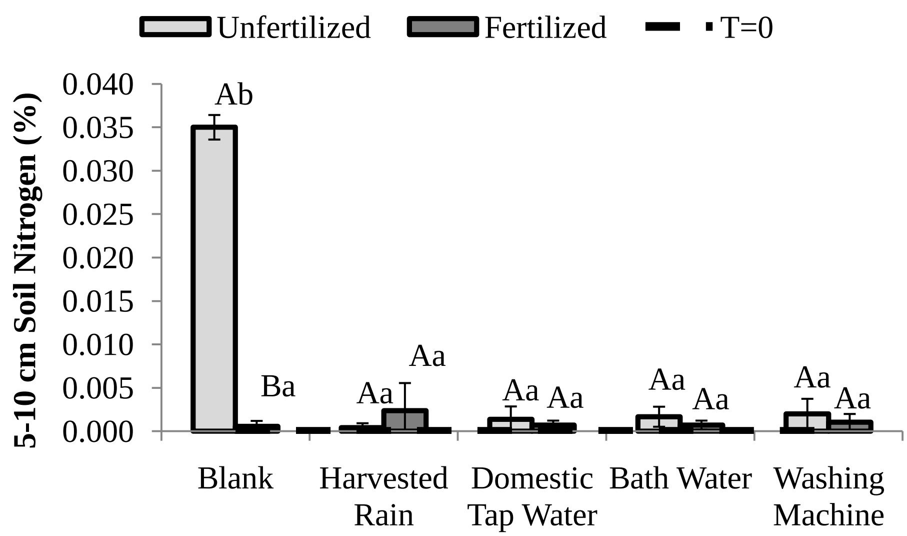

Figure 29. Percentage of nitrogen in the 5-9 cm sand layer for each treatment at the end of the experiment. . T=0 is the percentage of carbon in the sand before treatments commenced. Error bars are standard deviation. Blanks are pots with no vegetation and irrigated with harvested rain water. Different lowercase letters are significant difference ($p < 0.05$) between the treatment at T=0 and at 20 weeks. Uppercase letters signify significant difference between fertilized and unfertilized treatment.

3.7 Relationships between foliar, soil and leachate chemistries

Leachate DOC and DON had a strong and significant relationship with foliar carbon and nitrogen (Figure 30). There were no significant relationships between leachate DOC and DON and topsoil or sand layer carbon and nitrogen.

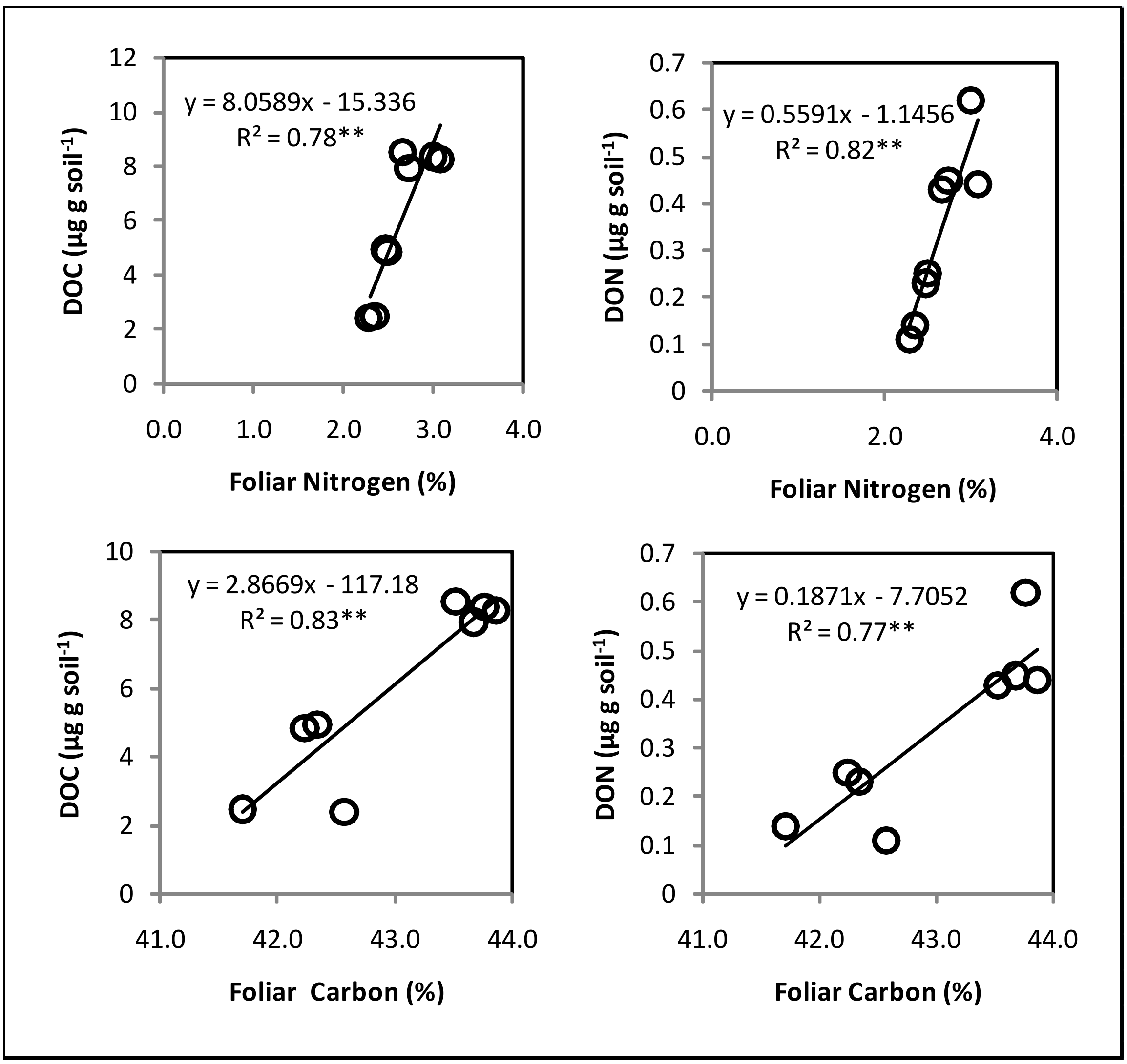

Figure 30. Relationships between leachate DOC and DON and foliar chemistry. Significance of relationship ** $p < 0.01$.

3.8 Quantification of greywater *E. coli* in irrigation water and leachate

Fifty-percent of fresh batches of greywater collected had *E.coli* colony counts higher than 1000 CFU per 100 mL (Table 10). I expected the bath water to have consistently higher *E.coli* colony counts than the washing machine water, but it only had a higher number for half the total collection, otherwise there was no consistent difference between washing machine and bath water (Table 10). *E. coli* was not detected in any of the greywater leachate analyzed at T2 (Table 10).

3.9 Soil microbial community composition

The principal component analysis of the FAME data indicated that there were no major differences among soil samples irrigated with tap water or greywater. However, there were discernable differences between those soils irrigated with harvested rainwater and those soils irrigated with bath water (Figure 31). The results also showed no consistent separation between fertilized or unfertilized samples suggesting that fertilization did not have major impacts on the composition of the dominant soil microbial populations (Figure 32-A). A total of thirteen fatty acids were recognized of which ten were determined to be of microbial origin (Gonzalez-Chavez et al. in review). The remainder may have been either of plant origin or derived from soaps and detergents used in the greywater. The relative abundance of total bacteria was strongly correlated with domestic tap water and greywater irrigated treatments than they were with rainwater irrigated treatments. In contrast, a significantly higher relative abundance of fungi (18:2 w6c and 18:1 w9c) was observed in the harvested rain water irrigated soils than in the soils irrigated with domestic tap water and greywater. A relatively small amount of protozoa (20:4 w6c) was also detected in the rain water and domestic tap water treatments (Figure 32-B).

Table 10. Greywater *E. coli* colony count for fresh collection (T1) and at sampling (7-9 days -T2). - Nd- no data, leachate was not analyzed because input counts were low. (F) is fertilized treatment and (U) is unfertilized treatment.

		Input	Extract	
Lot #	*I.D.*	*T1 CFUs/100ml*	*Treatment*	*T2 CFUs/100ml*
1	Bath	>100,000	Bath (F)	0
			Bath (U)	0
	Wash Machine	80	Wash (F)	0
			Wash (U)	0
2	Bath	>100,000	Bath (F)	0
			Bath (U)	0
	Wash Machine	2100	Wash (F)	0
			Wash (U)	0
3	Bath	300	Bath (F)	0
			Bath (U)	0
	Wash Machine	0	Wash (F)	Nd
			Wash (U)	Nd
4	Bath	80	Bath (F)	0
			Bath (U)	0
	Wash Machine	10	Wash (F)	0
			Wash (U)	0
5	Bath	0	Bath (F)	Nd
			Bath (U)	Nd
	Wash Machine	1300	Wash (F)	0
			Wash (U)	0
6	Bath	1100	Bath (F)	0
			Bath (U)	0
	Wash Machine	1420	Wash (F)	0
			Wash (U)	0

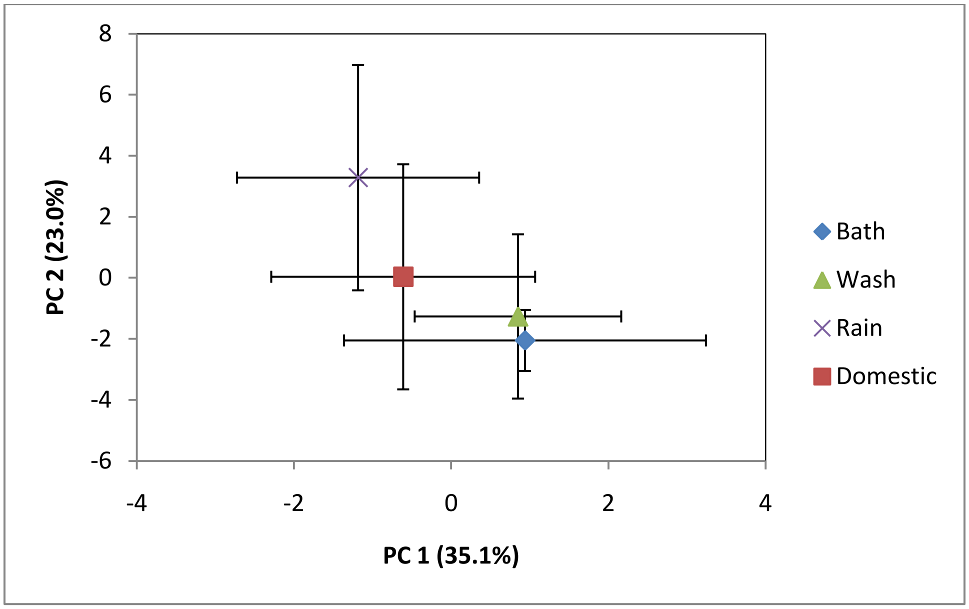

Figure 31. Principal component analysis of whole-soil FAME results for soil microorganisms under different turf irrigation treatments. Percentage of variance within the data set accounted for by each principal component is indicated in parentheses. Error bars are the standard deviation for each treatment for PC 1 and PC2.

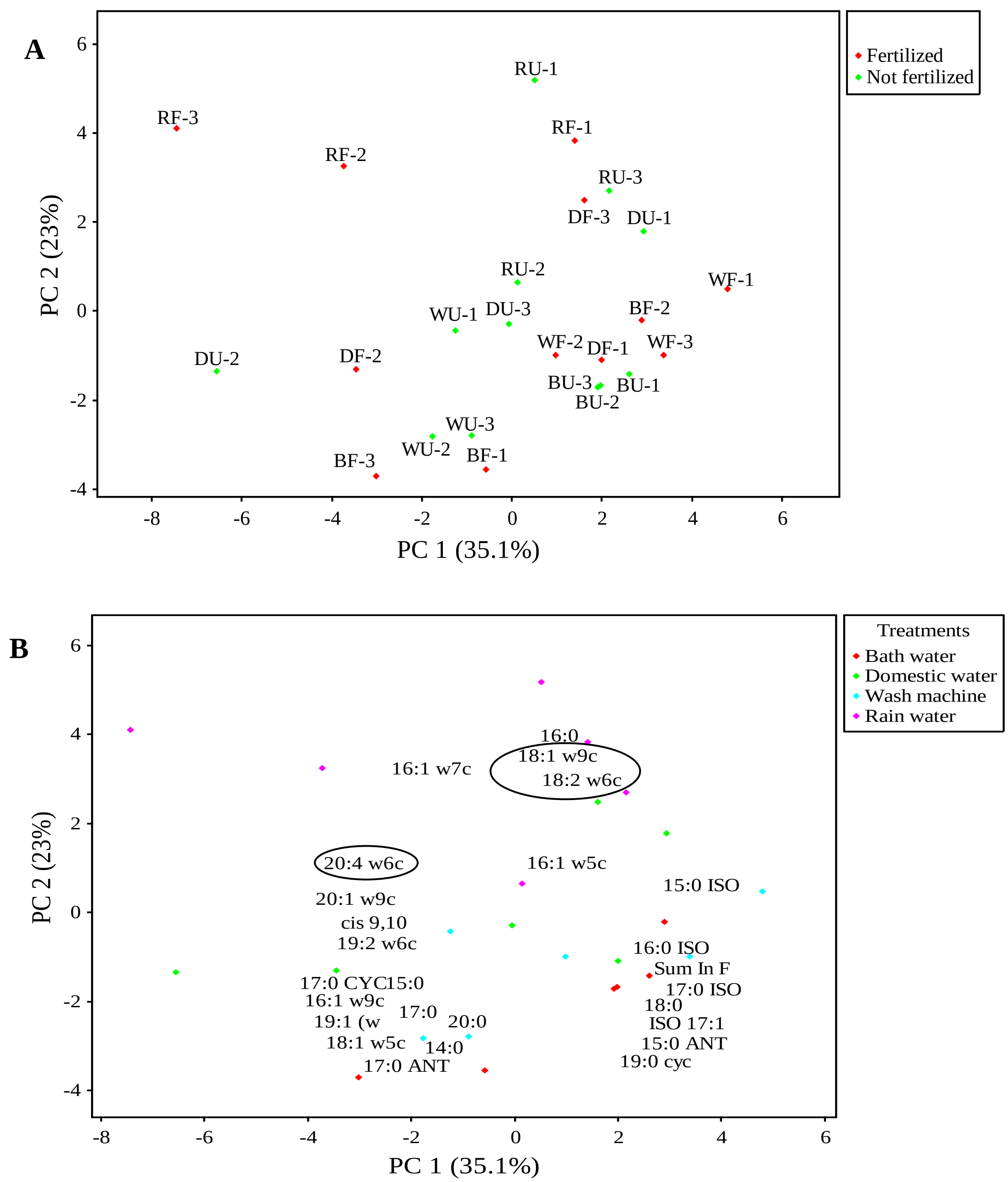

Figure 32. Principal component analysis of whole-soil FAME results for soil microorganisms illustrating A) effects of fertilization and B) correlation of treatments with individual fatty acids. The distribution of sample data points is identical in Figure A and B. Percentage of variance within the data set accounted for by each principal component is indicated in parentheses.

4. SUMMARY AND CONCLUSION

Decreasing availability of water resources for irrigating turfgrass in urban and suburban areas in southern USA has prompted many cities to restrict or ban irrigation during the summer months. This study examined the effect of using alternative irrigation waters for the irrigation of perennial ryegrass (*Lolium perenne L.*) on leachate chemistry, foliar carbon and nitrogen, soil carbon and nitrogen, and microbial community composition.

4.1 Leachate chemistry

Several studies have investigated the effect of using alternative water sources for irrigating turfgrass on soil chemistry and foliage (e.g. Hayes et al. 1990, Mancino and Pepper, 1992). Mancino and Pepper (1992) investigated the effect of using secondary treated effluent on soil chemistry under Bermuda grass over a 3.2 year period in Arizona, USA. They found that effluent water resulted in higher soil conductivity in the effluent treated plots compared to the plots irrigated with potable water and suggested that this was due to the significant difference in concentration of sodium between irrigation effluent and potable water. Their irrigation effluent sodium concentration ranged from 80-94 mg L^{-1} and their irrigation potable water sodium ranged from 14-30 mg L^{-1}, much lower than my values of 195 ± 35 mg L^{-1} for bath water, 189 ± 31 mg L^{-1} for washing machine water and 206 ± 25 mg L^{-1} for tap water used for irrigation. For my research, the leachate chemistry was significantly lower in conductivity in the rain irrigated treatments compared to the domestic tap and grey water irrigated treatments. Unlike the Mancino and Pepper (1992) study, the significant difference in leachate conductivity between my domestic water and grey water irrigated treatment cannot be attributed to significant differences in sodium content of the irrigation water. Mancino and Pepper (1992) also reported an increase in soil pH in their turfgrass irrigated with effluent. I found no significant increase in leachate pH when comparing domestic tap water and greywater leachate but a significant difference in pH when comparing them to leachate from treatments irrigated with harvested rain water.

4.1.1 Dissolved organic carbon and bicarbonate

Soils irrigated with effluent typically have higher leachate DOC flux than soils irrigated with freshwater (Jueschke et al. 2008). Orchard (avocado and grapefruit) and field (cotton, corn and sorghum) soils in the coastal plain of Israel were irrigated with freshwater and effluent. Dissolved organic carbon in soil percolates ranged from 15.8 to 35.1 mg kg^{-1} for freshwater irrigated soils and from 47.5 to 51.2 mg kg^{-1} for effluent irrigated soil. These fluxes of DOC were much lower than my fluxes resulting from irrigation of turfgrass which ranged from 76 to 127 mg kg^{-1} from domestic tap water irrigated soils, from 137 to 196 mg kg^{-1} from bath water irrigated soils and from 162 to 193 mg kg^{-1} from washing machine water irrigated soils but nevertheless illustrate that DOC flux from effluent irrigated fields is higher than from fields irrigated with freshwater. The difference between the DOC fluxes between my study and that of Jueschke et al. (2003) may be due to comparing a pot study to a field study or alternatively to a study where leachate was collected weekly compared to just two percolation values reported by Jueschke et al. (2003). Furthermore, the Jueschke et al. (2003) study had received irrigation for a number of years compared to the 20 weeks of my study.

In a study using effluent and potable water to irrigate mesocosms containing eucalyptus trees, Fine et al. (2002) reported different leachate total organic carbon (TOC) concentrations from a sand, an alfisol and a mollisol. Leachate TOC was 22 mg L^{-1} from sand, 30 mg L^{-1} from alfisols and 55 mg L^{-1} from a mollisol irrigated with domestic tap water compared to 160 mg L^{-1} from sand, 190 mg L^{-1} from the alfisols and 200 mg L^{-1} from the mollisol irrigated with effluent. My leachate DOC averaged 62 mg L^{-1} from soils irrigated with domestic tap water, 108 mg L^{-1} from soil irrigated with bath water and 96 mg L^{-1} from soil irrigated with washing machine water which are higher concentrations than Fine et al (2002) reported for potable water and lower than Fine et al. (2002) reported for effluent irrigated soils.

Flux of leachate DOC from my greywater irrigated treatments were significantly higher than from the domestic tap water and harvested rain water irrigated treatments. This could be the result of input surfactants within the greywater. The greywater washing machine and bath water had input surfactant DOC concentrations of 42.36 mg L^{-1} and 8.62 mg L^{-1} respectively, the higher surfactants in the washing machine water may also have been responsible for the net retention of DOC in soils irrigated with washing machine water. The relatively low release of DOC from soils irrigated with rain water may be due to different C compounds in rainwater compared to those in domestic tap, bath and washing machine water which led to a tighter cycling of carbon.

Effluent irrigation increases litter decomposition (Baker et al., 1990), this effect may have been responsible for the increase organic carbon from the decomposition of grass clippings that were cut and returned to the pots. In a separate experiment I extracted dried whole perennial ryegrass with ultra-pure water at a rate of 40 g grass clippings to 200 mL of water; the DOC concentration after two days was 39.98 mg L^{-1}, illustrating that the clippings do contribute to DOC production. Furthermore, with an average constant temperature of 32°C in the green house, this would support continuous microbial activity, likely resulting in the increased decomposition and ultimately increased production and decomposition of DOC in the leachate from the two greywater irrigated treatments over the period of the research.

Bicarbonate was the dominant inorganic carbon in irrigation waters and leachate waters in this study. High bicarbonate in irrigation water may have precipitated calcium under certain conditions and increased the proportion of sodium in soil solution on the cation exchange complex (Wilcox et al. 1954). In a pot study with grass, Wilcox et al. (1954) reported that the bicarbonate content of irrigation water sometimes markedly influenced the accumulation of exchangeable sodium in the soil and that this was due to the precipitation of $CaCO_3$. Drainage water bicarbonate concentrations were reported from several agricultural field sites in the Bahrain islands (Raveendran and Madany 1991). Concentrations ranged from 194 to 352 mg L^{-1} which were similar concentrations to the bicarbonate leached from soils irrigated with domestic tap water in my study. However, Raveendran and Madany (1991) attributed the high drainage bicarbonate concentrations to soil composition because soils are developed on limestone and gypsum rather than attributing the concentrations to the irrigation water chemistry. My soil was a fine sandy topsoil over a medium/coarse sand, and I assume limestone and gypsum contained within these materials was highly unlikely but this was not tested.

While there are many studies that have examined the effect of bicarbonate in irrigation water on soil sodium there is little in the literature that suggests that bicarbonate may be responsible for causing enhanced release of DOC and orthophosphate-P from irrigated soils (Pannkuk 2009). Pannkuk (2009) examined leachate DOC in landscape planted plots irrigated with domestic tap water in two locations in Texas. He found a significant relationship between leachate DOC and leachate bicarbonate at both locations irrespective of the type of landscape planting. My data also supports the speculation made by Aitkenhead-Peterson et al. (2009) that the correlation they found between DOC and bicarbonate concentrations in south-central Texas streams was due to irrigating turfgrass with high bicarbonate municipal tap water. The link between the two chemical constituents may not be direct but may instead be due to high sodium concentrations in the local tap water which is a $NaHCO_3$ water type. Unfortunately I did not quantify cations or anions in my leachates because of the effect of the surfactants on chromatography columns.

4.1.2 Orthophosphate-P

Irrigating with effluent resulted in higher output P flux due to greater input P flux in effluent compared to potable water (Mancino and Pepper 1992). This source of P in the greywater I suspect may be from detergents, soaps and shampoos. However, this was not evident when examining the ingredients or the MSDS for the product (Table 3). Phosphates are excellent builders in laundry detergents (Hammond 1971), and were often used as either sodium tripolyphosphate in dry granular detergents or as sodium/potassium phosphates in liquid detergents (ReVelle and ReVelle, 1988). Detergent phosphates were capable of tying up calcium, magnesium, iron and manganese ions, which improved washing performance (Duthie 1972). Phosphates also helped to peptize and suspend certain types of particulate matter (Duthie 1972). Current detergents contain zero or very low concentrations of phosphorus compounds and more enzymes (Maase and Tilburg 1983) but products for bathing have not reduced phosphates in anionic surfactants to the same extent. This is illustrated by my input orthophosphate-P values for bath and washing machine waters which was 0.20 and 0.02 mg kg^{-1} for bath and washing machine water respectively; a one order of magnitude difference between bath and washing machine water input P. Mancino and Pepper (1992) observed similar trends to those observed in this study. In their study examination of irrigation of turf grass with secondary sewage effluent they reported that the effluent water had significantly higher concentrations of P (27 mg L^{-1}) than the potable water (9 mg L^{-1}) resulting in effluent irrigated soils having significantly higher P concentrations. Hayes et al. (1990) and Mohammad and Mazahreh (2003) both reported similar trends of higher input P in the effluent water source which resulted in a higher P release from the soil. Mohammad and Mazahreh (2003) reported potable water and waste water P inputs at 0.03 mg kg^{-1} and 49 mg kg^{-1} respectively for irrigating vetch (*Vicia sativa*) and corn (*Zea mays*) crops in Jordan. My average input orthophosphate-P was similar at 0.04 mg kg^{-1} for domestic tap water but my greywater inputs were considerably lower. It should be noted however that Mohammad and Mazahreh (2003) input values are for the orthophosphate ion and not orthophosphate-P. Furthermore their interest was soil P and they reported that soil P increased by 4.9 mg kg^{-1} in soil irrigated with potable water and 9.9 mg kg^{-1} in soil irrigated with effluent. Hayes et al (1990) also reported an increase in soil P in soils under turfgrass irrigated with effluent near Tucson, Arizona. They found an increase in soil P of 20 mg kg^{-1} in the effluent treated soils but a loss of soil P of 13.7 mg kg^{-1} in soils irrigated with potable water. Although I did not quantify soil P I did find a net retention of orthophosphate-P in the soils irrigated with bath water and a net loss of orthophosphate-P from soils irrigated with domestic tap water, harvested rain water and washing machine water.

Typically orthophosphate is retained in soil adsorbing strongly to soil minerals (Nodvin et al. 1986), particularly to iron and aluminum precipitates and so it was surprising to find a net release of orthophosphate-P from all my irrigation treatments except the bath water irrigation treatment. This may be due to two major factors 1) a lack of iron and aluminum precipitates in the treatment soils and 2) an effect of pH. Shang et al. (1992) suggested that pH is an important factor affecting the adsorption of inorganic phosphate compounds by soils and their components with adsorption of orthophosphate decreasing with increasing pH. While the net release of orthophosphate-P was larger from the domestic tap water and washing machine water irrigated treatments compared to the harvested rain water irrigated treatments, this could be a function of increased pH in the domestic tap water and washing machine water, the pH was not however significantly different among the greywater and domestic tap water treatments and cannot explain the net retention of orthophosphate-P in the bath water irrigated treatments.

A standard method of extracting P from soils is using sodium bicarbonate (Olsen et al. 1954). High concentrations of sodium and bicarbonate in my domestic tap and grey water inputs (Table 2) may have resulted in the net loss of orthophosphate-P observed in the domestic tap water and washing machine water treatments.

4.1.3 Nitrogen species

The nitrogen concentrations in the leachate from the different treatments were not significantly different with the exception of the bath water irrigated treatments for DON, nitrate-N and ammonium-N during the 9^{th} to the 15^{th} week period of the research. The bath water used in this project was generated from bathing my two boys, who at that time were both under two years old. This increase in N during that period is possibly urine from one or both children in the bath water while they were having their baths during that time period. Interestingly urine produced urea was observed as input DON in my study, this was likely mineralized and then nitrified under aerobic conditions resulting in an enhanced output of nitrate (Figure 11). The urea form of nitrogen cannot be utilized directly by plants. It must be first converted to ammonium (which can be utilized by plants) or converted to nitrate. Nitrate, an anion is not readily adsorbed by soil minerals (Nodvin et al. 1986).

4.2 Examination of retention and release of carbon and nutrients

The adsorption of solute ions in a soil can be positive, as in the case of cation attachment to negatively charged clay or negative as in the case of anions which are repulsed or partially excluded from the electrostatic double layer of the same clay (Hillel, 1998). Hence, anions are typically routed into the center of pore spaces and move more rapidly through the soil profile when an electrolytic solution is introduced to the soil than cations (Hillel, 1998). In a low pH environment negatively charged clay edges, particularly kaolinite, can have positive charge which will attract anions. As my soil pH was relatively high, it was more likely that any anion adsorption in my soil was due to amorphous iron oxides (Jardine et al. 1989) or iron III oxyhydroxides which can form coatings on sand grains.

In controlled laboratory experiments, anions are typically retained or adsorbed in a soil matrix in the order $PO_4^{3-} > F^- > DOC^- > SO_4^{2-} > Cl^- > NO_3^-$ (Table 12; Nodvin et al., 1986). I examined retention or release of DOC and nutrients in my treatment using a modified mass isotherm approach (Nodvin et al. 1986), where input ions minus output ions could be considered retention (positive) or release (negative) of the ion or compound. Use of all input and release (RE) data irrespective of treatment gave a sufficient range to examine the adsorption co-efficient (m) and the order in which input anions were retained in my soils. I found the order of retention to be $HCO_3^- > DON^- > DOC^- > PO_4$-P (Table 11), very different to that reported by Nodvin et al. (1986) under controlled laboratory conditions. My data illustrates that bicarbonate is more strongly retained in soil than the other anions, particularly orthophosphate. This is not surprising considering that the typical use of 0.5 M sodium bicarbonate as an extractant for inorganic P from soils (Olsen et al. 1954; Turner and Heygarth 2003). In a large range of soils with multiple textures Turner and Heygarth (2003) removed between 5.8 (sandy soil) and 52.8 $\mu g\ g^{-1}$ (clayey soil) inorganic P. My values of P release were lower but nevertheless illustrated the impact of bicarbonate on P removal which ranged from 0.33 $\mu g\ g^{-1}$ in the rain irrigated treatments (low in input bicarbonate) to 4.70 $\mu g\ g^{-1}$ in bath water irrigated treatments (high in bicarbonate input) not dissimilar from the 5.8 $\mu g\ g^{-1}$ released from sandy soil in the Turner and Heygarth (2003) study. From the prior discussion it is apparent that orthophosphate-P is not retained in soil or taken up by plants as expected and bicarbonate on the other hand is retained in the soil to a greater extent than any of the other anions. To examine a chemical control on anion leaching I used stepwise regression analysis to determine the one strong and significant predictor of each anion in solution (Table 12). Clearly the excess of bicarbonate in irrigation water is causing anions adsorbed to mineral surfaces to be released (Table 12).

I was not able to estimate an adsorption coefficient for nitrate, a conservative ion and one that does not adsorb well to mineral soil (Nodvin et al. 1986). It is likely that any retention of nitrate in the soil was due to uptake by turfgrass and release to leachate would be expected.

The majority of harvested rain water irrigated treatments maintained a fairly tight cycle of retention and release for all added chemical constituents analyzed. This tight cycling is preferred as a release of nutrients could lead to ground water contamination.

Table 11. Typical adsorption coefficients of anions in mineral soil.

Anion	Nodvin et al. (1986)		This Study	
	m	R^2	m	R^2
HCO_3^-	nd	nd	0.74	0.99
DOC^-	0.60	1.0	0.54	0.64
[a]DON^-	0.63-0.90	0.99	0.56	0.93
PO_4^{-3}	0.99	1.0	0.47	0.57
NO_3^-	0.06	0.85	nd	nd

[a] Data from Kaiser and Zech (2001). Where m is the adsorption coefficient with a value < than 1 and R^2 is the strength of the relationship between input chemistry and RE (retention or release) chemistry.

Table 12. Predictive equations for anions in leachate.

Anion	**Predictive Equation**	R^2	**p**
PO_4-P	$0.024*E^{0.015*HCO_3}$	0.90	0.001
DOC^-	$2.127E^{0.011*HCO_3}$	0.85	0.001
DON^-	$0.092E^{0.013*HCO_3}$	0.76	0.001

4.3 Irrigation treatment effect on soil C and N

In the valley of the Mezquital in Mexico, agricultural crops have been irrigated with untreated sewage effluent from Mexico City for periods of 10 to 100 years. Soil organic carbon and total nitrogen in these agricultural soils increased with length of irrigation (Ramirez-Fuentes et al. 2002). Mancino and Pepper (1992) also examined soil C and N under Bermuda grass irrigated with secondary treated sewage effluent and potable water; they reported a doubling of soil carbon and a slight increase in soil nitrogen over a 2.5 year irrigating period. However, they found no significant difference in soil C or soil N between the two irrigation treatments at 2.5 years. My study examined soil carbon and nitrogen at 3 depths; the topsoil and the 0-5 and 5-9 cm sand layers. Contrary to the Mancino and Pepper (1992) study I found no significant difference in soil C in the topsoil and a significant decrease in topsoil carbon in the blanks (soil only) and domestic tap water irrigated treatments. An effect of greywater on soil C was only observed in the 5-9 cm sand layer where it was significantly reduced compared to the C content in the initial sand. Reduction in soil carbon may have been the result of C mineralization, a parameter not measured in this study or by high pH rendering humic acids soluble thus allowing their release to leachate. Mancino and Pepper (1992) suggested that soil C in their study was likely contributed by effluent and senescing roots and rhizomes. A difference between the Mancino and Pepper (1992) study and my study may be the longer duration of their study and thus more time for soil carbon to accumulate. Furthermore, I used a construction sand which is less likely to adsorb DOC either in the form of greywater C compounds or root exudates which are usually highly biodegradable (Wei et al., 2009).

Tertiary-treated effluent is often used to irrigate crops. Schipper et al. (1996) reported no difference in soil carbon and nitrogen values between their tertiary effluent-irrigated and potable water-irrigated plots. According to Schipper et al. (1996), the effluent used in their research was highly treated and so had lower nutrient concentrations than effluents reported in other studies.

Nitrogen was sequestered in the soil under Bermuda grass in the Arizona study conducted by Mancino and Pepper (1992). I saw some increases in soil N over the experimental period but due to the large variability between replicates this was not always a statistically significant increase relative to the initial soil N.

4.4 Biomass and foliar carbon and nitrogen

pH is essential to many chemical and biological reactions which depend on the levels of H^+ and OH^- ions in the soil (Brady and Weil, 1996). It influences solubility, and in turn availability, of several essential nutrient elements to plants (Brady and Weil, 1996). The municipal tap water and greywater had pH values over 8.5. At this high pH some plant species may be affected negatively as it affects the availability of some essential plant nutrients. There was no evidence of negative impact on the growth of the *Lolium perenne L.* used in this project and this may have been offset by additional nutrients in the greywater. The highest biomass production was observed in the bath water irrigated treatments and the lowest in the unfertilized tap water treatment which supports my speculation of additional nutrients offsetting a pH effect. The return of clipped turfgrass may have also helped to compensate for any additional nutrient losses. The bath water irrigation treatments had the highest biomass-N return but the other irrigation treatments showed no significant difference in biomass-N.

4.5 Relationships between foliar, soil, input and leachate chemistries

Significant and strong inverse relationships between foliar chemistry and water extractable dissolved organic carbon have been reported in forest soils (Aitkenhead-Peterson et al. 2006; Albrechtova et al. 2008). The latter study identified that chlorophyll contained in spruce needles was the likely N source driving the relationship between foliar N and DOC. The relationship between DOC and DON leachate and foliar chemistry was positive, strong and significant in my study. As foliar nitrogen increased so did the DOC and DON lost to leachate in turfgrass whereas in spruce and fir forests as foliar nitrogen increased DOC lost to leachate decreased. The mechanism may be that as 1) foliar N increases (as chlorophyll) so does the production of carbon compounds in the plant of which perhaps exudates are lost to leachate or 2) a thatch layer contribution to leachate DOC. While there may be a species effect between foliar and leachate chemistry, very little research has been done on the linkage between soil leachates and foliar chemistry thus far. Because of the high DOC concentrations in urban streams without waste water treatment plants and the link between DOC and urban open area land use (e.g. Aitkenhead-Peterson et al. 2009) the relationship between foliar chemistry and leachate DOC may prove to be useful in the future as a means to modeling those urban watersheds at risk of soil C loss through leached DOC.

4.6 Greywater *E. coli*

E. coli is used as an indicator for microbial pathogens which may be present in greywater. Recognizing the potential risk, the World Health Organization (WHO, 2006) has set guidelines for greywater usage, which stipulates that for the purpose of irrigation including ornamental uses, fruit trees and fodder crops, the quality of greywater to be used should contain

≤ 1000 CFUs (*E. coli*) 100mL. Several studies (Casanova et al., 2001b; Casanova et al., 2001c; Friedler et al., 2006), have evaluated greywater for fecal coliforms including *E. coli*. Their results have shown that *E. coli* counts are influenced by the time of year, the presence of children in a home, animals (pets) owned, above ground storage of water and the inclusion of kitchen sink water as a greywater irrigation source. The research done by Casanova et al. (2001a) included 11 households, some with children that were practicing greywater reuse. They sampled greywater from storage areas and soil irrigated with greywater as well as soil irrigated with potable water over a period of 1 year (January-December).

In my assessment of freshly collected greywater over the period of the research, I observed counts of *E. coli* ranging from >100,000 to 0 CFU per 100 mL for both bath and washing machine water. Yet, regardless of the numbers observed from the fresh collection, movement through the soil profile was negative. However, *E. coli* was not enumerated in water samples immediately prior to irrigation. It is possible that *E. coli* populations may have either decreased or been eliminated during storage of the water. A limitation of this study is the lack of testing storage containers for *E. coli* during the course of the experiment. I also did not examine the soil for *E. coli* to determine if they may have been retained by the soil. Both of these measures of *E. coli* would have helped to address some remaining uncertainties regarding the results. Casanova et al. (2001a) reported *E. coli* detection on at least one occasion at all sites and in 12 of 13 greywater irrigated soils. Their report suggested that the difference between sites irrigated with greywater and sites irrigated with potable water indicated that irrigation with greywater may introduce *E. coli* into the soil that would not otherwise be present. They also reported that sites that included kitchen sink water had higher counts of *E. coli* than sites irrigated with washing machine and/or bath water.

4.7 Microbial community composition

The distinct difference observed from the PCA of the FAME data suggested that some of the water sources selected for different soil microbial populations. Studies have shown that higher soil microbial concentrations are often observed in soils irrigated with wastewater. Zhang et al., (2008) investigated the effects of long-term sewage irrigation on microbial structural and functional characterizations in agricultural soil in Shandong, China. Their soil samples included groundwater irrigated, groundwater and wastewater irrigated and sewage irrigated soils where soil samples were collected from a depth of 2-20cm. Using FAME analysis, Zhang et al. (2008) reported greater diversity in microbial composition in sewage irrigated soil and soils partially irrigated with groundwater and sewage water compared to groundwater only irrigated soil. I found no significant difference in major groups of biomarkers among soils irrigated with different water treatments with the exception of fungi which had a significantly higher relative abundance in rain irrigated soils compared to soils irrigated with domestic tap water and greywater (Figure 32-B). The difference in microbial composition results between my study and Zhang et al. (2008) may be the length time of soil exposure to irrigation treatments. In the Zhang et al. (2008) study, the soil was constantly irrigated with sewage obtained from a river for more than 30 years versus the duration of my research which was 5 months (21 weeks). Unfortunately, Zhang et al. (2008) does not indicate whether the sewage in the river used in his study was raw sewage that had been treated.

The relative abundance of the selected marker FAMEs for bacteria were similar for all treatments (Figure 32-B). However, PCA indicated compositional differences between the rainwater and greywater irrigated treatments for fungi. The rainwater irrigated soil contained a strongly positive abundance of the FAMEs 18:2 w6c and 18:1 w9c which are contained in fungi.

These microorganisms are known to degrade complex carbon compounds. In contrast, the greywater irrigated soil contained strongly positive abundance of the FAMEs 19:0 cyclo c11-12 compared to the rain irrigated soil, which are contained in Gram-negative microorganisms (Figure 32-B). The proteobacteria are a major group of Gram-negative bacteria which include *E. coli* among others. I found no relationships between input chemistry and FAME markers or output leachate and FAME markers.

Zhang et al. (2008) reported that wastewater influenced protozoa and bacteria populations (Zhang et al., 2008), I found some evidence of protozoa among tap water and rain water with the fatty acid marker 20:4w6c (Figure 32-B). In my opinion, time seems to play an important role on these factors as the soils analyzed in other research projects were exposed to their respective irrigation treatments for a significantly longer period than soil in my research.

4.8 Limitations to study and conclusion

There were significant differences among leachate chemistry which was a function of the quality of irrigation water used. Higher fluxes of nutrients were detected in leachate from greywater irrigated treatments as a result of higher input concentrations. Rainwater irrigated treatments maintained a constant rate of nutrient release over the period of the experiment as well as a fairly tight cycle of nutrient retention and release. Irrigation and fertilization treatment significantly affected foliar and soil carbon and nitrogen. To maintain terrestrial nutrient cycling and avoid leachate losses to surface waters it is recommended that harvested rainwater would be best for irrigating urban landscapes where possible.

Greywater recycling may however be of vital importance in sustaining a potable water supply. It can be used without fertilizers because of the high concentrations of nutrients it can supply to the soil resulting in greater economical benefit as it can reduce the frequency of fertilizer application. However, the concerns surrounding possible human health risks associated with its microbial content cannot be ignored. While I encountered no *E. coli* colonies in leachates indicative of little movement through the soil profile, I did not test the soil for *E. coli* and neither did I test the input solutions for *E. coli* during every leaching event. Due to the conditions in which my greywaters were kept between leaching (high temperature and aerated) it is possible that the *E. coli* died off. Principal component analysis of the FAME data showed a distinctly different microbial community composition in harvested rain irrigated treatments compared to soils irrigated with greywater.

REFERENCES

Aitkenhead-Peterson J. A., Steele M.K., Nahar N., and Santhy K. 2009. Dissolved organic carbon and nitrogen in urban and rural watersheds of south-central Texas: Land use and land management influences. Biogeochemistry DOI: 10.1007/s10533-009-9348-2 96:119-129.

Aitkenhead-Peterson J. A., Alexander J. E., Albrechtová J., Lhotakova Z., Huntley R., Rock B., Cudlin, P., Krám P., Hruška J., Polak T., Oulehle F., and McDowell W.H. 2006. Linking foliar chemistry to forest floor solid and solute phase organic C and N in Norway spruce stands in northern Bohemia. Plant Soil, 283, 193-207, DOI: 10.1007/s11104-006-0010-7.

Albrechtova J., Seidl Z., Aitkenhead-Peterson J. A., Lhotakova Z., Rock B., Alexander J. E., Malenovsky Z. and McDowell W. H. 2008. Spectral analysis of coniferous foliage and possible links to soil chemistry: Can remote sensing of foliage predict variation in soil C and N chemistry? Sci. Tot. Env. 404: 424-432.

Abdol Hamid, H.R., W.M. Kassim, A. El Hishir, and S.A. El-Jawashi. 2008. Risk assessment and remediation suggestion of impacted soil by produced water associated with oil production. Environ Monit Assess 145:95-102.

Baker, T.G., W.J. Dyck, P.G. Barton, G.R. Oliver, and G. Nicholson. 1990. Effects of irrigation with effluent on decomposition of litter in pinus-radiata forests. Forest Ecology and Management 31:205-214.

Bian, B., and W. Zhu. 2009. Particle size distribution and pollutants in road-deposited sediments in different areas of Zhenjiang, China. Environmental Geochemistry and Health 31:511-520.

Blanchoud, H., E. Moreau-Guigon, F. Farrugia, M. Chevreuil, and J.M. Mouchel. 2007. Contribution by urban and agricultural pesticide uses to water contamination at the scale of the Marne watershed. Science of the Total Environment 375:168-179.

Bossio, D. A., and K. M. Scow. 1998. Impacts of carbon and flooding on soil microbial communities: Phospholipid fatty acid profiles and substrate utilization patterns. Microbial Ecology 35, 263-278.

Botalova, O., J. Schwarzbauer, T. Frauenrath, and L. Dsikowitzky. 2009. Identification and chemical characterization of specific organic constituents of petrochemical effluents. Water Research 43:3797-3812.

Brady, N., Weil, R. 1996. The nature and properties of soils. 11th ed. Prentice Hall, Inc., Upper Saddle River., NJ.

Casanova, L., V. Little, R. Frye, and C. Gerber. 2001a. A survey of the microbial quality of recycled household greywater. J. Am.Water. Res. Assoc. 37:1313-1319.

Casanova, L.M., C.P. Gerba, and M. Karpiscak. 2001b. Chemical and microbial characterization of household greywater. J Environ Sci Health A Tox Hazard Subst Environ Eng 36:395-401.

Casanova, L.M., V. Little, R.J. Frye, and C.P. Gerba. 2001c. A survey of the microbial quality of recycled household greywater. J. Am. Water. Res. Assoc. 37:1313-1319.

Cavigelli, M. A., G. P. Robertson, and M. J. Klug. 1995. Fatty acid methyl ester (FAME) . profiles as measures of soil microbial community structure. Plant and Soil 170, 99-113.

Chang, M.T., M.W. McBroom, and R.S. Beasley. 2004. Roofing as a source of nonpoint water pollution. J. Environ. Mgnt. 73:307-315.

Chen C. 2007. A framework for graywater recycling of household wastewater. Polish J.Environ. studies 16:23-33.

Christians, N. 1998. Fundamentals of turfgrass management. 3rd ed. Ann Arbor Press, Chelsea,MI.

Duthie, J.R. 1972. Detergents: Nutrients considerations and total assessment, pp. 205-216, In G. E. Likens, (ed.) Nutrients and eutrophication: The limiting-nutrient controversy, Limnology and Oceanography,Special Symposium No. 1: 205-216.

Emrath, P. 2000. Residential Water Use. Housing Economics 48:6-10.

Eriksson, E., K. Auffarth, M. Henze, and A. Ledin. 2002. Characteristics of grey wastewater. Urban Water 4(1):85-104.

Evans, C.A., P.J. Coombes, and R.H. Dunstan. 2006. Wind, rain and bacteria: The effect of weather on the microbial composition of roof-harvested rainwater. Water Res 40:37-44.

Fine, P., A. Hass, R. Prost, and N. Atzmon. 2002. Organic carbon leaching from effluent irrigated lysimeters as affected by residence time. Soil Sci. Soc. Am. J. 66:1531-1539.

Friedler, E., R. Kovalio, and A. Ben-Zvi. 2006. Comparative study of the microbial quality of greywater treated by three on-site treatment systems. Environ. Technol. 27:653-663.

Gonzalez-Chavez, M. C., J. A. Aitkebnhead-Peterson, T. Gentry, D. Zuberer, F. Hons and R. Loeppert (in review). Impact of long-term tillage and crop rotations on C, N and P pools and soil microbial communities. Soil Tillage Res.

Hammond, A.L. 1971. Phosphate replacements: Problems with the washday miracle. Sci., 172: 361-363.

Hayashi, T., T. Tokunaga, M. Aichi, J. Shimada, and M. Taniguchi. 2008. Effects of human activities and urbanization on groundwater environments: An example from the aquifer system of Tokyo and the surrounding area. Sci Total Environ.407:3165-3172.

Hayes, A.R., C.F. Mancino, and I.L. Pepper. 1990. Irrigation of turfgrass with secondary sewage effluent .1. Soil and leachate water-quality. Agron. J. 82:939-943.

Hernandez Leal, L., G. Zeeman, H. Temmink, and C. Buisman. 2007. Characterisation and biological treatment of greywater. Water Sci Technol 56:193-200.

Hilaire, R.S., M.A. Arnold, D.C. Wilkerson, D.A. Devitt, B.H. Hurd, B.J. Lesikar, V.I. Lohr, C.A. Martin, G.V. McDonald, R.L. Morris, D.R. Pittenger, D.A. Shaw, and D.F. Zoldoske. 2008. Efficient water use in residential urban landscapes. Hortscience 43:2081-2092.

Hillel, D., 1998 Soil physics. 2nd edition. Academic Press, San Diego, CA.

Hutson, S., N. Barber, J. Kenny, K. Linsey, D. Lumia, and M. M. 2004. Estimated use of water in the United States in 2000: Reston VA, U.S. Geological Survey, Circular 1268, 46p.

Jardine P.M., N.L.Weber, and J.F. McCarthy., 1989. Mechanisms of dissolved organic carbon adsorption on soil. Soil Sci. Soc. Am. J. 53:1378-1385.

Jefferson, B., A. Palmer, P. Jeffrey, R. Stuetz, and S. Judd. 2004. Greywater characterisation and its impact on the selection and operation of technologies for urban reuse. Water Sci Technol 50:157-64.

Jueschke, E., B. Marschner, J. Tarchitzky, and Y. Chen. 2008. Effects of treated wastewater irrigation on the dissolved and soil organic carbon in Israeli soils. Water Sci. Technol. 57:727-733.

Lye, D.J. 2002. Health risks associated with consumption of untreated water from household roof catchment systems. J. Am. Water Res. Assoc. 38:1301-1306.

Maase F. W. J. L and van Tilburg R. 1983 The benefit of detegent enzymes under changing washing conditions. J. Am. Oil Chemist Soc. 60:1672-1675.

Mancino, C.F., and I.L. Pepper. 1992. Irrigation of turfgrass with secondary sewage effluent - soil quality. Agron. J. 84:650-654.

Mohammad, M.J., and N. Mazahreh. 2003. Changes in soil fertility parameters in response to irrigation of forage crops with secondary treated wastewater. Communications in Soil Science and Plant Analysis 34:1281-1294.

Nodvin, S.C., C.T. Driscoll, and G.E. Likens. 1986. Simple partioning of anions and dissolved organic-carbon in a forest soil. Soil Sci. 142:27-35.

Olsen, S.R., F.S. Watanabe, H.R. Cosper, W.E. Larson, and L.B. Nelson. 1954. Residual phosphorus availability in long-time rotations on calcareous soils. Soil Sci. 78:141-151.

Onodera, S., M. Saito, M. Sawano, T. Hosono, M. Taniguchi, J. Shimada, Y. Umezawa, R.F. Lubis, S. Buapeng, and R. Delinom. 2008. Effects of intensive urbanization on the intrusion of shallow groundwater into deep groundwater: Examples from Bangkok and Jakarta. Sci Total Environ 404:401-10.

Pannkuk, T. 2009. Evapotranspiration and leachate quality of warm-season turf and native grasses under different Texas landscape climates, Ph.D. Dissertation, Texas A&M University, College Station.

Pidou, M., L. Avery, T. Stephenson, P. Jeffrey, S.A. Parsons, S. Liu, F.A. Memon, and B. Jefferson. 2008. Chemical solutions for greywater recycling. Chemosphere 71:147-55.

Ramirez-Fuentes E., Lucho-Constantino C., Escamilla-Silva E. and Dendooven L. 2002 Characteristics, and carbon and nitrogen dynamics in soil irrigated with wastewater for different lengths of time. Bioresource Technology 85: 179-187.

Raveendran, E., and I.M. Madany. 1991. Characteristics of agricultural drainage water in Bahrain. Sci. Total Environ. 104:239-247.

ReVelle, P. and C. ReVelle. 1988. The environment: Issues and choices for society. 3rd edition. Jones and Bartlett Publishers, Boston.

Sazakli, E., A. Alexopoulos, and M. Leotsinidis. 2007. Rainwater harvesting, quality assessment and utilization in Kefalonia Island, Greece. Water Res 41:2039-47.

Schipper, L.A., J.C. Williamson, H.A. Kettles, and T.W. Speir. 1996. Impact of land-applied tertiary-treated effluent on soil biochemical properties. J. Environ. Qua. 25:1073-1077.

Shang, C., J.W.B. Stewart, and P.M. Huang. 1992. pH effect on kinetics of adsorption of organic and inorganic phosphates by short-range ordered aluminum and iron precipitates. Geoderma 53:1-14.

Turner B. L. and Haygarth P. M 2003 Changes in bicarbonate-extractable iornganic and organic phosphorous by drying pasture soils. Soil Sci. Soc. Am. J. 67:344-350.

USEPA 2002 Method 1603: *Escherichia* coli in water by membrane filtration using modified membrane-thermotolerant *Escherichia* coli agar. EPA-821-R-02-023.

U.N.W.W.A.P. 2003. 1st UN World Water Development Report: Water for People, Water for Life. UNESCO (United Nations Educational, Scientific and Cultural Organization) and Berghahn Books, Paris, New York and Oxford.

Wei, L.L., Q.L. Zhao, S. Xue, C.C. Chang, F. Tang, G.L. Liang, and T. Jia. 2009. Reduction of trihalomethane precursors of dissolved organic matter in the secondary effluent by advanced treatment processes. J. Hazardous Materials 169:1012-1021.

WHO (World Health Organization) 2006. Overview of greywater management Health considerations, http://www.emro.who.int/Ceha/Publication_Details.asp?ID=120.

Wilcox, L.V., G.Y. Blair, and C.A. Bower. 1954. Effects of bicarbonate on suitability of water for irrigation. Soil Sci. 77:259-266.

Zhang, Y.L., J.L. Dai, R.Q. Wang, and J. Zhang. 2008. Effects of long-term sewage irrigation on agricultural soil microbial structural and functional characterizations in Shandong, China. European J. Soil Bio. 44:84-91.

APPENDICES

Appendix A. Codes for samples

Code	Irrigation
RRU	Unfertilized Harvested Rain Water
RRF	Fertilized Harvested Rain Water
DRU	Unfertilized Tap Water
DRF	Fertilized Tap Water
BRU	Unfertilized Bath Water
BRF	Fertilized Bath Water
WRU	Unfertilized Washing Machine Water
WRF	Fertilizer Washing Machine Water

Appendix B. Soil masses, input and output volumes and pH and conductivity

Date	Sample ID	Rep. #	Volume In mL	Volume Out mL	Top Soil (g)	Sand (g)	pH	EC µS cm^{-1}
6/9/2008	DRF	1	1200	282	459.225	2800	7.52	2740
6/9/2008	DRF	2	1200	282	459.225	2800	6.87	2000
6/9/2008	DRF	3	1200	282	459.225	2800	7.29	1500
6/9/2008	DRU	1	1200	282	459.225	2800	6.76	1800
6/9/2008	DRU	2	1200	282	459.225	2800	7.53	1100
6/9/2008	DRU	3	1200	282	459.225	2800	6.93	1430
6/9/2008	BRF	1	1200	294	459.225	2800	7.4	1480
6/9/2008	BRF	2	1200	294	459.225	2800	7.53	1210
6/9/2008	BRF	3	1200	294	459.225	2800	7.27	1560
6/9/2008	BRU	1	1200	294	459.225	2800	6.67	3330
6/9/2008	BRU	2	1200	294	459.225	2800	7.37	1400
6/9/2008	BRU	3	1200	294	459.225	2800	7.34	1140
6/9/2008	WRF	1	1200	326	459.225	2800	7.15	1270
6/9/2008	WRF	2	1200	326	459.225	2800	7.07	1600
6/9/2008	WRF	3	1200	326	459.225	2800	6.97	3190
6/9/2008	WRU	1	1200	326	459.225	2800	7.17	1620
6/9/2008	WRU	2	1200	326	459.225	2800	6.67	2750
6/9/2008	WRU	3	1200	326	459.225	2800	7.38	1770
6/9/2008	RRF	1	1200	297	459.225	2800	6.55	1410
6/9/2008	RRF	2	1200	297	459.225	2800	6.54	990
6/9/2008	RRF	3	1200	297	459.225	2800	6.74	1560
6/9/2008	RRU	1	1200	297	459.225	2800	6.97	1480
6/9/2008	RRU	2	1200	297	459.225	2800	6.24	1840
6/9/2008	RRU	3	1200	297	459.225	2800	6.47	1790
6/9/2008	BLANK F	1	1200	284	459.225	2800	6.87	880
6/9/2008	BLANK F	2	1200	1200	1200	1200	6.5	1990
6/9/2008	BLANK U	1	1200	1200	1200	1200	6.63	790
6/16/2008	DRF	1	1200	282	459.225	2800	8.41	1050
6/16/2008	DRF	2	1200	282	459.225	2800	8.37	1090
6/16/2008	DRF	3	1200	282	459.225	2800	8.27	940
6/16/2008	DRU	1	1200	282	459.225	2800	8.07	960
6/16/2008	DRU	2	1200	282	459.225	2800	8.33	740
6/16/2008	DRU	3	1200	282	459.225	2800	8.11	750
6/16/2008	BRF	1	1200	294	459.225	2800	8.49	1210
6/16/2008	BRF	2	1200	294	459.225	2800	8.63	830
6/16/2008	BRF	3	1200	294	459.225	2800	8.25	1090
6/16/2008	BRU	1	1200	294	459.225	2800	7.55	1070
6/16/2008	BRU	2	1200	294	459.225	2800	8.04	720
6/16/2008	BRU	3	1200	294	459.225	2800	8.45	690
6/16/2008	WRF	1	1200	326	459.225	2800	8.27	780

6/16/2008	WRF	2	1200	326	459.225	2800	8.11	1210
6/16/2008	WRF	3	1200	326	459.225	2800	8.2	1480
6/16/2008	WRU	1	1200	326	459.225	2800	8.07	960
6/16/2008	WRU	2	1200	326	459.225	2800	7.57	1440
6/16/2008	WRU	3	1200	326	459.225	2800	8.27	890
6/16/2008	RRF	1	1200	297	459.225	2800	7.4	1120
6/16/2008	RRF	2	1200	297	459.225	2800	7.49	460
6/16/2008	RRF	3	1200	297	459.225	2800	7.44	760
6/16/2008	RRU	1	1200	297	459.225	2800	7.75	760
6/16/2008	RRU	2	1200	297	459.225	2800	7.5	1070
6/16/2008	RRU	3	1200	297	459.225	2800	7.51	700
6/16/2008	BLANK F	1	1200	284	459.225	2800	8.04	470
6/16/2008	BLANK F	2	1200	284	459.225	2800	7.76	710
6/16/2008	BLANK U	1	1200	284	459.225	2800	7.93	340
6/23/2008	DRF	1	1200	282	459.225	2800	8.29	1180
6/23/2008	DRF	2	1200	282	459.225	2800	8.23	1250
6/23/2008	DRF	3	1200	282	459.225	2800	8.17	1280
6/23/2008	DRU	1	1200	282	459.225	2800	8.37	1280
6/23/2008	DRU	2	1200	282	459.225	2800	8.31	1190
6/23/2008	DRU	3	1200	282	459.225	2800	8.47	980
6/23/2008	BRF	1	1200	294	459.225	2800	8.63	1330
6/23/2008	BRF	2	1200	294	459.225	2800	8.57	1130
6/23/2008	BRF	3	1200	294	459.225	2800	8.41	1360
6/23/2008	BRU	1	1200	294	459.225	2800	7.17	1570
6/23/2008	BRU	2	1200	294	459.225	2800	7.77	1390
6/23/2008	BRU	3	1200	294	459.225	2800	8.77	670
6/23/2008	WRF	1	1200	326	459.225	2800	7.99	1180
6/23/2008	WRF	2	1200	326	459.225	2800	8.09	1880
6/23/2008	WRF	3	1200	326	459.225	2800	8.33	1720
6/23/2008	WRU	1	1200	326	459.225	2800	8.27	1220
6/23/2008	WRU	2	1200	326	459.225	2800	8.43	1500
6/23/2008	WRU	3	1200	326	459.225	2800	8.57	1220
6/23/2008	RRF	1	1200	297	459.225	2800	7.5	1120
6/23/2008	RRF	2	1200	297	459.225	2800	7.6	470
6/23/2008	RRF	3	1200	297	459.225	2800	7.59	970
6/23/2008	RRU	1	1200	297	459.225	2800	7.83	650
6/23/2008	RRU	2	1200	297	459.225	2800	7.47	1330
6/23/2008	RRU	3	1200	297	459.225	2800	7.8	560
6/23/2008	BLANK F	1	1200	284	459.225	2800	7.53	490
6/23/2008	BLANK F	2	1200	284	459.225	2800	7.4	760
6/23/2008	BLANK U	1	1200	284	459.225	2800	7.91	340
6/30/2008	DRF	1	1200	282	459.225	2800	8.42	1060
6/30/2008	DRF	2	1200	282	459.225	2800	8.37	1050
6/30/2008	DRF	3	1200	282	459.225	2800	8.43	1140

6/30/2008	DRU	1	1200	282	459.225	2800	8.61	1030
6/30/2008	DRU	2	1200	282	459.225	2800	8.46	940
6/30/2008	DRU	3	1200	282	459.225	2800	8.51	740
6/30/2008	BRF	1	1200	294	459.225	2800	8.68	1120
6/30/2008	BRF	2	1200	294	459.225	2800	8.56	880
6/30/2008	BRF	3	1200	294	459.225	2800	8.49	1290
6/30/2008	BRU	1	1200	294	459.225	2800	8.29	1520
6/30/2008	BRU	2	1200	294	459.225	2800	8.27	1180
6/30/2008	BRU	3	1200	294	459.225	2800	8.55	930
6/30/2008	WRF	1	1200	326	459.225	2800	8.47	1130
6/30/2008	WRF	2	1200	326	459.225	2800	8.3	1410
6/30/2008	WRF	3	1200	326	459.225	2800	8.37	1150
6/30/2008	WRU	1	1200	326	459.225	2800	8.55	1080
6/30/2008	WRU	2	1200	326	459.225	2800	8.47	1010
6/30/2008	WRU	3	1200	326	459.225	2800	8.63	1000
6/30/2008	RRF	1	1200	297	459.225	2800	7.44	910
6/30/2008	RRF	2	1200	297	459.225	2800	7.52	410
6/30/2008	RRF	3	1200	297	459.225	2800	7.33	410
6/30/2008	RRU	1	1200	297	459.225	2800	7.96	440
6/30/2008	RRU	2	1200	297	459.225	2800	7.62	850
6/30/2008	RRU	3	1200	297	459.225	2800	7.66	510
6/30/2008	BLANK F	1	1200	284	459.225	2800	7.57	900
6/30/2008	BLANK F	2	1200	284	459.225	2800	7.59	470
6/30/2008	BLANK U	1	1200	284	459.225	2800	7.71	710
7/7/2008	DRF	1	1200	282	459.225	2800	8.17	1570
7/7/2008	DRF	2	1200	282	459.225	2800	8.41	1040
7/7/2008	DRF	3	1200	282	459.225	2800	8.16	940
7/7/2008	DRU	1	1200	282	459.225	2800	8.52	870
7/7/2008	DRU	2	1200	282	459.225	2800	8.59	910
7/7/2008	DRU	3	1200	282	459.225	2800	8.47	900
7/7/2008	BRF	1	1200	294	459.225	2800	8.67	1250
7/7/2008	BRF	2	1200	294	459.225	2800	8.51	950
7/7/2008	BRF	3	1200	294	459.225	2800	8.54	1160
7/7/2008	BRU	1	1200	294	459.225	2800	8.4	1480
7/7/2008	BRU	2	1200	294	459.225	2800	8.3	1080
7/7/2008	BRU	3	1200	294	459.225	2800	8.65	950
7/7/2008	WRF	1	1200	326	459.225	2800	8.35	1060
7/7/2008	WRF	2	1200	326	459.225	2800	8.11	1500
7/7/2008	WRF	3	1200	326	459.225	2800	8.14	1510
7/7/2008	WRU	1	1200	326	459.225	2800	7.82	1000
7/7/2008	WRU	2	1200	326	459.225	2800	8.02	1440
7/7/2008	WRU	3	1200	326	459.225	2800	8.26	1210
7/7/2008	RRF	1	1200	297	459.225	2800	7.06	850
7/7/2008	RRF	2	1200	297	459.225	2800	7.15	340

7/7/2008	RRF	3	1200	297	459.225	2800	6.69	600
7/7/2008	RRU	1	1200	297	459.225	2800	7.99	410
7/7/2008	RRU	2	1200	297	459.225	2800	7.9	820
7/7/2008	RRU	3	1200	297	459.225	2800	8	
7/7/2008	BLANK F	1	1200	284	459.225	2800	7.91	340
7/7/2008	BLANK F	2	1200	284	459.225	2800	6.38	350
7/7/2008	BLANK U	1	1200	284	459.225	2800	7.81	300
7/14/2008	DRF	1	1200	282	459.225	2800	8.37	1200
7/14/2008	DRF	2	1200	282	459.225	2800	8.16	880
7/14/2008	DRF	3	1200	282	459.225	2800	8.37	1070
7/14/2008	DRU	1	1200	282	459.225	2800	8.39	990
7/14/2008	DRU	2	1200	282	459.225	2800	8.37	980
7/14/2008	DRU	3	1200	282	459.225	2800	8.34	720
7/14/2008	BRF	1	1200	294	459.225	2800	8.82	1560
7/14/2008	BRF	2	1200	294	459.225	2800	8.78	1140
7/14/2008	BRF	3	1200	294	459.225	2800	8.77	1340
7/14/2008	BRU	1	1200	294	459.225	2800	8.52	1750
7/14/2008	BRU	2	1200	294	459.225	2800	8.36	1330
7/14/2008	BRU	3	1200	294	459.225	2800	8.69	1080
7/14/2008	WRF	1	1200	326	459.225	2800	8.36	1140
7/14/2008	WRF	2	1200	326	459.225	2800	8.54	1620
7/14/2008	WRF	3	1200	326	459.225	2800	8.52	1880
7/14/2008	WRU	1	1200	326	459.225	2800	8.48	1370
7/14/2008	WRU	2	1200	326	459.225	2800	8.55	1500
7/14/2008	WRU	3	1200	326	459.225	2800	8.49	1360
7/14/2008	RRF	1	1200	297	459.225	2800	7.71	480
7/14/2008	RRF	2	1200	297	459.225	2800	7.69	250
7/14/2008	RRF	3	1200	297	459.225	2800	7.34	590
7/14/2008	RRU	1	1200	297	459.225	2800	8.07	330
7/14/2008	RRU	2	1200	297	459.225	2800	7.78	790
7/14/2008	RRU	3	1200	297	459.225	2800	7.69	310
7/14/2008	BLANK F	1	1200	284	459.225	2800	7.94	320
7/14/2008	BLANK F	2	1200	284	459.225	2800	8.22	470
7/14/2008	BLANK U	1	1200	284	459.225	2800	8.03	290
7/21/2008	DRF	1	1050	150	459.225	2800	9.13	1050
7/21/2008	DRF	2	1050	150	459.225	2800	8.89	1240
7/21/2008	DRF	3	1050	132	459.225	2800	9.26	1590
7/21/2008	DRU	1	1050	144	459.225	2800	9.25	1360
7/21/2008	DRU	2	1050	132	459.225	2800	9.11	1030
7/21/2008	DRU	3	1050	132	459.225	2800	9.19	930
7/21/2008	BRF	1	1050	144	459.225	2800	9.24	1550
7/21/2008	BRF	2	1050	144	459.225	2800	9.25	1270
7/21/2008	BRF	3	1050	144	459.225	2800	9.27	1470
7/21/2008	BRU	1	1050	144	459.225	2800	9.15	1800

7/21/2008	BRU	2	1050	144	459.225	2800	9.21	1560
7/21/2008	BRU	3	1050	144	459.225	2800	9.21	1210
7/21/2008	WRF	2	1050	176	459.225	2800	9.08	1790
7/21/2008	WRF	3	1050	176	459.225	2800	9.19	1800
7/21/2008	WRF	1	1050	176	459.225	2800	9.13	1240
7/21/2008	WRU	1	1050	176	459.225	2800	9.19	1300
7/21/2008	WRU	2	1050	176	459.225	2800	9.06	1450
7/21/2008	WRU	3	1050	176	459.225	2800	9.1	1430
7/21/2008	RRF	2	1050	147	459.225	2800	8.38	300
7/21/2008	RRF	1	1050	147	459.225	2800	8.38	660
7/21/2008	RRF	3	1050	147	459.225	2800	8.3	530
7/21/2008	RRU	1	1050	0	459.225	2800	8.48	260
7/21/2008	RRU	2	1050	147	459.225	2800	8.39	700
7/21/2008	RRU	3	1050	147	459.225	2800	8.36	430
7/21/2008	BLANK F	1	1050	134	459.225	2800	8.36	380
7/21/2008	BLANK F	2	1050	134	459.225	2800	8.31	520
7/21/2008	BLANK U	1	1050	134	459.225	2800	8.54	350
7/29/2008	DRF	1	1050	132	459.225	2800	8.85	290
7/29/2008	DRF	2	1050	132	459.225	2800	8.89	1040
7/29/2008	DRF	3	1050	132	459.225	2800	9	1000
7/29/2008	DRU	1	1050	132	459.225	2800	9.08	960
7/29/2008	DRU	2	1050	132	459.225	2800	9.09	1060
7/29/2008	DRU	3	1050	132	459.225	2800	9.03	700
7/29/2008	BRF	1	1050	144	459.225	2800	9.04	1410
7/29/2008	BRF	2	1050	144	459.225	2800	8.83	1350
7/29/2008	BRF	3	1050	144	459.225	2800	8.98	1360
7/29/2008	BRU	1	1050	144	459.225	2800	8.61	1450
7/29/2008	BRU	2	1050	144	459.225	2800	8.47	1470
7/29/2008	BRU	3	1050	144	459.225	2800	8.47	1280
7/29/2008	WRF	1	1050	176	459.225	2800	8.86	1160
7/29/2008	WRF	2	1050	176	459.225	2800	9.05	1670
7/29/2008	WRF	3	1050	176	459.225	2800	8.84	1380
7/29/2008	WRU	1	1050	176	459.225	2800	9.05	1190
7/29/2008	WRU	2	1050	176	459.225	2800	9	1250
7/29/2008	WRU	3	1050	176	459.225	2800	8.84	1180
7/29/2008	RRF	1	1050	147	459.225	2800	8.29	360
7/29/2008	RRF	2	1050	147	459.225	2800	8.34	230
7/29/2008	RRF	3	1050	147	459.225	2800	8.12	420
7/29/2008	RRU	1	1050	147	459.225	2800	8.35	250
7/29/2008	RRU	2	1050	147	459.225	2800	8.44	550
7/29/2008	RRU	3	1050	147	459.225	2800	8.41	270
7/29/2008	BLANK F	1	1050	134	459.225	2800	8.24	260
7/29/2008	BLANK F	2	1050	134	459.225	2800	8.19	410
7/29/2008	BLANK U	1	1050	134	459.225	2800	8.42	290

8/4/2008	DRF1	1	1200	276.01	459.225	2800	8.7	1020
8/4/2008	DRF2	2	1200	236.12	459.225	2800	8.73	760
8/4/2008	DRF3	3	1200	286.74	459.225	2800	8.63	920
8/4/2008	DRU1	1	1200	302.26	459.225	2800	8.78	1000
8/4/2008	DRU2	2	1200	282.05	459.225	2800	8.82	1030
8/4/2008	DRU3	3	1200	310.01	459.225	2800	8.72	710
8/4/2008	BRF1	1	1200	340.05	459.225	2800	8.43	1540
8/4/2008	BRF2	2	1200	228.22	459.225	2800	8.51	1400
8/4/2008	BRF3	3	1200	306.32	459.225	2800	8.68	1530
8/4/2008	BRU1	1	1200	293	459.225	2800	8.17	1490
8/4/2008	BRU2	2	1200	318	459.225	2800	8.4	1570
8/4/2008	BRU3	3	1200	276.15	459.225	2800	8.42	1380
8/4/2008	WRF1	1	1200	339.99	459.225	2800	8.18	1050
8/4/2008	WRF2	2	1200	314.14	459.225	2800	8.35	1270
8/4/2008	WRF3	3	1200	344.24	459.225	2800	8.28	1190
8/4/2008	WRU1	1	1200	370.31	459.225	2800	8.33	1150
8/4/2008	WRU2	2	1200	328.53	459.225	2800	8.3	1070
8/4/2008	WRU3	3	1200	256.03	459.225	2800	8.27	1130
8/4/2008	RRF1	1	1200	342.05	459.225	2800	8.09	300
8/4/2008	RRF2	2	1200	306.25	459.225	2800	8.01	250
8/4/2008	RRF3	3	1200	280.22	459.225	2800	8.02	310
8/4/2008	RRU1	1	1200	198.61	459.225	2800	8.11	220
8/4/2008	RRU2	2	1200	290.17	459.225	2800	8.14	330
8/4/2008	RRU3	3	1200	362.25	459.225	2800	7.92	220
8/4/2008	B1F	1	1200	328.66	459.225	2800	8.06	310
8/4/2008	B2F	2	1200	272.03	459.225	2800	8.01	340
8/4/2008	B1U	1	1200	250.08	459.225	2800	8.16	230
8/11/2008	DRF1	1	1200	282.05	459.225	2800	8.84	1080
8/11/2008	DRF2	2	1200	194.45	459.225	2800	8.81	870
8/11/2008	DRF3	3	1200	274.34	459.225	2800	8.69	1030
8/11/2008	DRU1	1	1200	312.04	459.225	2800	8.89	1000
8/11/2008	DRU2	2	1200	188.03	459.225	2800	9.11	1150
8/11/2008	DRU3	3	1200	278.02	459.225	2800	8.83	800
8/11/2008	BRF1	1	1200	320.46	459.225	2800	8.75	1920
8/11/2008	BRF2	2	1200	318.01	459.225	2800	8.56	1570
8/11/2008	BRF3	3	1200	286.07	459.225	2800	8.79	1849
8/11/2008	BRU1	1	1200	305.15	459.225	2800	8.37	1750
8/11/2008	BRU2	2	1200	264.47	459.225	2800	8.58	1620
8/11/2008	BRU3	3	1200	295.01	459.225	2800	8.58	1630
8/11/2008	WRF1	1	1200	376.05	459.225	2800	8.28	1150
8/11/2008	WRF2	2	1200	229.99	459.225	2800	8.49	1540
8/11/2008	WRF3	3	1200	340.03	459.225	2800	8.49	1320
8/11/2008	WRU1	1	1200	360.03	459.225	2800	8.34	1170
8/11/2008	WRU2	2	1200	320.2	459.225	2800	8.41	1260

8/11/2008	WRU3	3	1200	254.01	459.225	2800	8.63	1250
8/11/2008	RRF1	1	1200	354.5	459.225	2800	8.09	310
8/11/2008	RRF2	2	1200	355.95	459.225	2800	8.08	230
8/11/2008	RRF3	3	1200	252.02	459.225	2800	7.94	290
8/11/2008	RRU1	1	1200	367.99	459.225	2800	8.03	180
8/11/2008	RRU2	2	1200	350.12	459.225	2800	8.08	470
8/11/2008	RRU3	3	1200	282.07	459.225	2800	8.21	210
8/11/2008	Blank1F	1	1200	280.51	459.225	2800	8.11	330
8/11/2008	Blank2F	2	1200	350.09	459.225	2800	8.02	390
8/11/2008	Blank1U	1	1200	256.44	459.225	2800	8.23	320
8/18/2008	DRF1	1	750	174.95	459.225	2800	8.96	1230
8/18/2008	DRF2	2	750	262.55	459.225	2800	8.68	960
8/18/2008	DRF3	3	750	244.87	459.225	2800	8.78	1480
8/18/2008	DRU1	1	750	262.67	459.225	2800	8.97	1110
8/18/2008	DRU2	2	750	232.42	459.225	2800	9.08	1240
8/18/2008	DRU3	3	750	314.27	459.225	2800	8.94	910
8/18/2008	BRF1	1	750	220.67	459.225	2800	8.95	2340
8/18/2008	BRF2	2	750	204.8	459.225	2800	8.81	2050
8/18/2008	BRF3	3	750	219.61	459.225	2800	9.06	1960
8/18/2008	BRU1	1	750	234.42	459.225	2800	8.62	2080
8/18/2008	BRU2	2	750	223.29	459.225	2800	8.68	2000
8/18/2008	BRU3	3	750	278.1	459.225	2800	8.78	1800
8/18/2008	WRF1	1	750	287.34	459.225	2800	8.7	1310
8/18/2008	WRF2	2	750	316.02	459.225	2800	8.72	1440
8/18/2008	WRF3	3	750	362.52	459.225	2800	8.77	1500
8/18/2008	WRU1	1	750	303.07	459.225	2800	8.71	1350
8/18/2008	WRU2	2	750	350.48	459.225	2800	8.83	1410
8/18/2008	WRU3	3	750	338.61	459.225	2800	8.97	1390
8/18/2008	RRF1	1	750	293.92	459.225	2800	7.99	330
8/18/2008	RRF2	2	750	294.96	459.225	2800	7.83	210
8/18/2008	RRF3	3	750	308.03	459.225	2800	7.67	300
8/18/2008	RRU1	1	750	359.88	459.225	2800	7.86	210
8/18/2008	RRU2	2	750	215.8	459.225	2800	8.18	380
8/18/2008	RRU3	3	750	297.81	459.225	2800	7.94	220
8/18/2008	B1F	1	750	256.35	459.225	2800	8.45	270
8/18/2008	B2F	2	750	272.97	459.225	2800	7.92	430
8/18/2008	B1U	1	750	332.81	459.225	2800	8.11	250
8/25/2008	DRF1	1	750	210.23	459.225	2800	8.75	1040
8/25/2008	DRF2	2	750	234.64	459.225	2800	8.7	1360
8/25/2008	DRF3	3	750	204.76	459.225	2800	8.64	910
8/25/2008	DRU1	1	750	258.03	459.225	2800	8.89	1020
8/25/2008	DRU2	2	750	172.28	459.225	2800	8.89	1090
8/25/2008	DRU3	3	750	268.02	459.225	2800	8.73	800
8/25/2008	BRF1	1	750	181.52	459.225	2800	8.77	1820

8/25/2008	BRF2	2	750	236.76	459.225	2800	8.44	1640
8/25/2008	BRF3	3	750	268.03	459.225	2800	8.77	1720
8/25/2008	BRU1	1	750	293.04	459.225	2800	8.39	1470
8/25/2008	BRU2	2	750	206.42	459.225	2800	8.33	1280
8/25/2008	BRU3	3	750	218.73	459.225	2800	8.55	1580
8/25/2008	WRF1	1	750	237.85	459.225	2800	8.4	1140
8/25/2008	WRF2	2	750	196.63	459.225	2800	8.51	1250
8/25/2008	WRF3	3	750	318.02	459.225	2800	8.46	1210
8/25/2008	WRU1	1	750	318.01	459.225	2800	8.46	1100
8/25/2008	WRU2	2	750	240.83	459.225	2800	8.43	1200
8/25/2008	WRU3	3	750	237.67	459.225	2800	8.66	1030
8/25/2008	RRF1	1	750	244.84	459.225	2800	8.25	270
8/25/2008	RRF2	2	750	234.47	459.225	2800	8.25	170
8/25/2008	RRF3	3	750	212.6	459.225	2800	8.29	220
8/25/2008	RRU1	1	750	202.9	459.225	2800	8.36	220
8/25/2008	RRU2	2	750	183.85	459.225	2800	8.44	250
8/25/2008	RRU3	3	750	228.54	459.225	2800	8.17	230
8/25/2008	Blank1F	1	750	273.01	459.225	2800	8.33	230
8/25/2008	Blank2F	2	750	203.3	459.225	2800	8.21	240
8/25/2008	Blank1U	1	750	216.14	459.225	2800	8.22	170
9/1/2008	DRF1	1	750	175.02	459.225	2800	8.71	1020
9/1/2008	DRF2	2	750	190.56	459.225	2800	8.57	950
9/1/2008	DRF3	3	750	205.02	459.225	2800	8.89	940
9/1/2008	DRU1	1	750	219.61	459.225	2800	8.85	840
9/1/2008	DRU2	2	750	303.01	459.225	2800	9	1080
9/1/2008	DRU3	3	750	275.05	459.225	2800	8.77	810
9/1/2008	BRF1	1	750	303	459.225	2800	8.88	1970
9/1/2008	BRF2	2	750	345.05	459.225	2800	8.69	1490
9/1/2008	BRF3	3	750	229.01	459.225	2800	8.6	1730
9/1/2008	BRU1	1	750	293	459.225	2800	8.37	1500
9/1/2008	BRU2	2	750	177.05	459.225	2800	8.42	1470
9/1/2008	BRU3	3	750	331.11	459.225	2800	8.81	1540
9/1/2008	WRF1	1	750	237.05	459.225	2800	8.44	1380
9/1/2008	WRF2	2	750	217.03	459.225	2800	8.35	1120
9/1/2008	WRF3	3	750	331.01	459.225	2800	8.76	1290
9/1/2008	WRU1	1	750	285.05	459.225	2800	8.3	1110
9/1/2008	WRU2	2	750	281.01	459.225	2800	8.41	1200
9/1/2008	WRU3	3	750	307.04	459.225	2800	8.79	1280
9/1/2008	RRF1	1	750	325.02	459.225	2800	8.08	310
9/1/2008	RRF2	2	750	337.02	459.225	2800	7.75	270
9/1/2008	RRF3	3	750	325	459.225	2800	8.03	210
9/1/2008	RRU1	1	750	273	459.225	2800	7.87	260
9/1/2008	RRU2	2	750	275.04	459.225	2800	7.75	220
9/1/2008	RRU3	3	750	323.03	459.225	2800	7.73	210

9/1/2008	Blank1F	1	750	225.04	459.225	2800	8.12	270
9/1/2008	Blank2F	2	750	335.03	459.225	2800	7.8	230
9/1/2008	Blank1U	1	750	240.58	459.225	2800	8.06	190
9/8/2008	DRF1	2	750	275.02	459.225	2800	8.83	900
9/8/2008	DRF2	3	750	345.02	459.225	2800	8.86	890
9/8/2008	DRF3	1	750	309	459.225	2800	8.87	770
9/8/2008	DRU1	2	750	343	459.225	2800	8.96	810
9/8/2008	DRU2	3	750	303	459.225	2800	8.98	890
9/8/2008	DRU3	1	750	261.01	459.225	2800	8.86	790
9/8/2008	BRF1	2	750	323.04	459.225	2800	8.94	1680
9/8/2008	BRF2	3	750	305.03	459.225	2800	8.82	1420
9/8/2008	BRF3	1	750	223	459.225	2800	8.9	1690
9/8/2008	BRU1	2	750	263.05	459.225	2800	8.45	1480
9/8/2008	BRU2	3	750	293	459.225	2800	8.69	1500
9/8/2008	BRU3	1	750	253.03	459.225	2800	8.76	1410
9/8/2008	WRF1	2	750	283.01	459.225	2800	8.69	1510
9/8/2008	WRF2	3	750	275.09	459.225	2800	8.75	1340
9/8/2008	WRF3	1	750	223.03	459.225	2800	8.74	1310
9/8/2008	WRU1	2	750	285.03	459.225	2800	8.56	1220
9/8/2008	WRU2	3	750	271	459.225	2800	8.66	1410
9/8/2008	WRU3	1	750	275.04	459.225	2800	8.71	1200
9/8/2008	RRF1	2	750	263.03	459.225	2800	8.01	270
9/8/2008	RRF2	3	750	293.12	459.225	2800	7.85	470
9/8/2008	RRF3	1	750	297.11	459.225	2800	7.97	230
9/8/2008	RRU1	2	750	241.01	459.225	2800	8.09	220
9/8/2008	RRU2	3	750	311.02	459.225	2800	8.05	240
9/8/2008	RRU3	1	750	225.01	459.225	2800	7.9	260
9/8/2008	B1F	2	750	303.05	459.225	2800	8.11	170
9/8/2008	B2F	1	750	273.12	459.225	2800	8.01	190
9/8/2008	B1U	1	750	285	459.225	2800	8.18	200
9/15/2008	DRF1	1	750	309.03	459.225	2800	8.81	840
9/15/2008	DRF2	2	750	305.02	459.225	2800	8.88	840
9/15/2008	DRF3	3	750	219.01	459.225	2800	8.74	740
9/15/2008	DRU1	1	750	261	459.225	2800	8.89	850
9/15/2008	DRU2	2	750	233.06	459.225	2800	8.88	850
9/15/2008	DRU3	3	750	363.02	459.225	2800	8.83	840
9/15/2008	BRF1	1	750	327	459.225	2800	8.88	1470
9/15/2008	BRF2	2	750	363.01	459.225	2800	8.92	1360
9/15/2008	BRF3	3	750	307.03	459.225	2800	8.98	1580
9/15/2008	BRU1	1	750	293.03	459.225	2800	8.54	1480
9/15/2008	BRU2	2	750	245.03	459.225	2800	8.77	1430
9/15/2008	BRU3	3	750	339.04	459.225	2800	8.84	1270
9/15/2008	WRF1	1	750	353	459.225	2800	8.77	1490
9/15/2008	WRF2	2	750	353.04	459.225	2800	8.83	1250

9/15/2008	WRF3	3	750	359	459.225	2800	8.6	1420
9/15/2008	WRU1	1	750	253.04	459.225	2800	8.49	1230
9/15/2008	WRU2	2	750	285.04	459.225	2800	8.59	1280
9/15/2008	WRU3	3	750	353.04	459.225	2800	8.83	1170
9/15/2008	RRF1	1	750	237	459.225	2800	8.1	240
9/15/2008	RRF2	2	750	323.02	459.225	2800	7.73	340
9/15/2008	RRF3	3	750	343.04	459.225	2800	7.83	220
9/15/2008	RRU1	1	750	285.01	459.225	2800	7.97	230
9/15/2008	RRU2	2	750	339.02	459.225	2800	8.02	270
9/15/2008	RRU3	3	750	383	459.225	2800	7.88	200
9/15/2008	B1F	1	750	351.05	459.225	2800	8.07	160
9/15/2008	B2F	2	750	329.02	459.225	2800	7.96	200
9/15/2008	B1U	1	750	359	459.225	2800	8.07	190
9/22/2008	DRF1	1	750	293.04	459.225	2800	8.94	1000
9/22/2008	DRF2	2	750	333.01	459.225	2800	8.99	770
9/22/2008	DRF3	3	750	329.01	459.225	2800	8.7	760
9/22/2008	DRU1	1	750	341.02	459.225	2800	8.98	820
9/22/2008	DRU2	2	750	273.05	459.225	2800	8.78	860
9/22/2008	DRU3	3	750	343.02	459.225	2800	8.96	880
9/22/2008	BRF1	1	750	383.08	459.225	2800	9.09	1610
9/22/2008	BRF2	2	750	373.01	459.225	2800	9.06	1200
9/22/2008	BRF3	3	750	327.08	459.225	2800	9.12	1410
9/22/2008	BRU1	1	750	344.64	459.225	2800	8.76	1470
9/22/2008	BRU2	2	750	303.03	459.225	2800	8.91	1360
9/22/2008	BRU3	3	750	337.03	459.225	2800	8.98	1370
9/22/2008	WRF1	1	750	325.04	459.225	2800	8.92	1470
9/22/2008	WRF2	2	750	307.09	459.225	2800	8.84	1110
9/22/2008	WRF3	3	750	173.01	459.225	2800	8.93	1410
9/22/2008	WRU1	1	750	300.64	459.225	2800	8.68	1290
9/22/2008	WRU2	2	750	373.01	459.225	2800	8.79	1370
9/22/2008	WRU3	3	750	325.05	459.225	2800	9.02	1340
9/22/2008	RRF1	1	750	337.58	459.225	2800	8	200
9/22/2008	RRF2	2	750	323.06	459.225	2800	7.86	200
9/22/2008	RRF3	3	750	363.06	459.225	2800	7.71	320
9/22/2008	RRU1	1	750	289.08	459.225	2800	7.9	230
9/22/2008	RRU2	2	750	349.05	459.225	2800	8.19	320
9/22/2008	RRU3	3	750	363.04	459.225	2800	7.88	200
9/22/2008	Blank1F	1	750	323.06	459.225	2800	8.06	190
9/22/2008	Blank2F	2	750	305.06	459.225	2800	8.05	180
9/22/2008	Blank1U	1	750	375.04	459.225	2800	8.08	190
9/29/2008	DRF1	1	750	287.05	459.225	2800	8.92	810
9/29/2008	DRF2	2	750	273.04	459.225	2800	8.86	720
9/29/2008	DRF3	3	750	389.01	459.225	2800	8.76	820
9/29/2008	DRU1	1	750	241.04	459.225	2800	8.97	670

9/29/2008	DRU2	2	750	273.09	459.225	2800	8.87	700
9/29/2008	DRU3	3	750	281.05	459.225	2800	8.83	700
9/29/2008	BRF1	1	750	239.05	459.225	2800	9.07	1170
9/29/2008	BRF2	2	750	251.06	459.225	2800	9.05	1100
9/29/2008	BRF3	3	750	233.03	459.225	2800	8.95	1410
9/29/2008	BRU1	1	750	169.03	459.225	2800	9.03	1000
9/29/2008	BRU2	2	750	241.03	459.225	2800	8.89	1340
9/29/2008	BRU3	3	750	193.03	459.225	2800	8.95	1310
9/29/2008	WRF1	1	750	273	459.225	2800	8.91	1340
9/29/2008	WRF2	2	750	273	459.225	2800	8.93	1180
9/29/2008	WRF3	3	750	239.01	459.225	2800	9.12	1310
9/29/2008	WRU1	1	750	143	459.225	2800	8.94	1390
9/29/2008	WRU2	2	750	261.03	459.225	2800	8.95	1350
9/29/2008	WRU3	3	750	231	459.225	2800	9.08	1380
9/29/2008	RRF1	1	750	243	459.225	2800	7.94	200
9/29/2008	RRF2	2	750	229.01	459.225	2800	7.77	440
9/29/2008	RRF3	3	750	195.09	459.225	2800	7.87	200
9/29/2008	RRU1	1	750	211.02	459.225	2800	8.06	240
9/29/2008	RRU2	2	750	261.04	459.225	2800	8.08	280
9/29/2008	RRU3	3	750	217.03	459.225	2800	7.87	190
9/29/2008	Blank1F	1	750	279.02	459.225	2800	8.1	180
9/29/2008	Blank2F	2	750	289.05	459.225	2800	8.05	170
9/29/2008	Blank1U	1	750	261	459.225	2800	8.1	180
10/5/2008	DRF1	1	600	141.01	459.225	2800	8.81	790
10/5/2008	DRF2	2	600	217.05	459.225	2800	8.75	800
10/5/2008	DRF3	3	600	195.07	459.225	2800	8.62	680
10/5/2008	DRU1	1	600	275.04	459.225	2800	8.88	760
10/5/2008	DRU2	2	600	175.01	459.225	2800	8.57	650
10/5/2008	DRU3	3	600	235.04	459.225	2800	8.72	710
10/5/2008	BRF1	1	750	117.04	459.225	2800	9.22	650
10/5/2008	BRF2	2	600	177.01	459.225	2800	8.99	1130
10/5/2008	BRF3	3	750	181.06	459.225	2800	9.2	1190
10/5/2008	BRU1	1	750	101.03	459.225	2800	9.13	1260
10/5/2008	BRU2	2	750	143.05	459.225	2800	8.99	1320
10/5/2008	BRU3	3	750	179.05	459.225	2800	9.19	1200
10/5/2008	WRF1	1	750	229.1	459.225	2800	8.88	1300
10/5/2008	WRF2	2	750	253.03	459.225	2800	8.8	1140
10/5/2008	WRF3	3	750	131.01	459.225	2800	9.04	1320
10/5/2008	WRU1	1	750	97.05	459.225	2800	9.01	1310
10/5/2008	WRU2	2	750	213.05	459.225	2800	9	1230
10/5/2008	WRU3	3	600	147.03	459.225	2800	9.08	1200
10/5/2008	RRF1	1	750	195.05	459.225	2800	8.21	130
10/5/2008	RRF2	2	750	201	459.225	2800	8.32	170
10/5/2008	RRF3	3	750	109.06	459.225	2800	8.25	150

10/5/2008	RRU1	1	750	129	459.225	2800	8.35	160
10/5/2008	RRU2	2	750	267.06	459.225	2800	8.2	190
10/5/2008	RRU3	3	750	191.05	459.225	2800	8.04	120
10/5/2008	Blank1F	1	750	211.04	459.225	2800	8.16	160
10/5/2008	Blank2F	2	600	101.03	459.225	2800	8.07	140
10/5/2008	Blank1U	1	750	207.02	459.225	2800	8.28	130
10/13/2008	DRF1	1	750	275.03	459.225	2800	8.85	1160
10/13/2008	DRF2	2	750	313.06	459.225	2800	8.94	1010
10/13/2008	DRF3	3	750	343.03	459.225	2800	8.81	970
10/13/2008	DRU1	1	750	351.01	459.225	2800	9.03	1050
10/13/2008	DRU2	2	750	249.07	459.225	2800	8.85	1030
10/13/2008	DRU3	3	750	307.05	459.225	2800	8.89	1190
10/13/2008	BRF1	1	750	185.05	459.225	2800	9.13	1840
10/13/2008	BRF2	2	750	293.05	459.225	2800	9.08	1240
10/13/2008	BRF3	3	750	253	459.225	2800	9.14	1820
10/13/2008	BRU1	1	750	185.05	459.225	2800	9.1	2060
10/13/2008	BRU2	2	750	263.05	459.225	2800	8.97	1600
10/13/2008	BRU3	3	750	273.01	459.225	2800	8.88	1840
10/13/2008	WRF1	1	750	329.02	459.225	2800	9.07	1420
10/13/2008	WRF2	2	750	341.03	459.225	2800	9.04	1500
10/13/2008	WRF3	3	750	265.02	459.225	2800	9.03	1540
10/13/2008	WRU1	1	750	211.07	459.225	2800	8.84	1730
10/13/2008	WRU2	2	750	283.04	459.225	2800	9.06	1520
10/13/2008	WRU3	3	750	359.01	459.225	2800	9.18	1580
10/13/2008	RRF1	1	750	173.08	459.225	2800	8.05	180
10/13/2008	RRF2	2	750	179.01	459.225	2800	7.98	300
10/13/2008	RRF3	3	750	131.05	459.225	2800	8.13	140
10/13/2008	RRU1	1	750	291.1	459.225	2800	8.06	270
10/13/2008	RRU2	2	750	209	459.225	2800	7.98	200
10/13/2008	RRU3	3	750	193.07	459.225	2800	8.07	220
10/13/2008	Blank1F	1	750	213.03	459.225	2800	8	250
10/13/2008	Blank2F	2	750	219	459.225	2800	7.97	200
10/13/2008	Blank1U	1	750	225.04	459.225	2800	8.01	190
10/19/2008	DRF1	1	750	321.04	459.225	2800	8.68	1210
10/19/2008	DRF2	2	750	385.03	459.225	2800	8.87	1060
10/19/2008	DRF3	3	750	389.05	459.225	2800	8.92	1010
10/19/2008	DRU1	1	750	367.03	459.225	2800	9.02	1040
10/19/2008	DRU2	2	750	205.06	459.225	2800	8.89	1040
10/19/2008	DRU3	3	750	367.04	459.225	2800	8.97	1270
10/19/2008	BRF1	1	750	215.02	459.225	2800	9.2	1840
10/19/2008	BRF2	2	750	309.01	459.225	2800	9.08	1100
10/19/2008	BRF3	3	750	307.02	459.225	2800	9.16	1760
10/19/2008	BRU1	1	750	231.02	459.225	2800	9.04	1980
10/19/2008	BRU2	2	750	233	459.225	2800	9.04	1710

10/19/2008	BRU3	3	750	275.06	459.225	2800	9.03	1700
10/19/2008	WRF1	1	750	359.05	459.225	2800	9.07	1380
10/19/2008	WRF2	2	750	307.04	459.225	2800	9.01	1260
10/19/2008	WRF3	3	750	281.04	459.225	2800	9.05	1620
10/19/2008	WRU1	1	750	249.02	459.225	2800	8.95	1630
10/19/2008	WRU2	2	750	327.03	459.225	2800	9.06	1390
10/19/2008	WRU3	3	750	333.03	459.225	2800	9.07	1370
10/19/2008	RRF1	1	750	217.06	459.225	2800	8.28	170
10/19/2008	RRF2	2	750	229.04	459.225	2800	8.08	220
10/19/2008	RRF3	3	750	175	459.225	2800	8.02	230
10/19/2008	RRU1	1	750	215.02	459.225	2800	8.05	240
10/19/2008	RRU2	2	750	317.05	459.225	2800	8.09	180
10/19/2008	RRU3	3	750	247.05	459.225	2800	7.96	200
10/19/2008	Blank1F	1	750	221.01	459.225	2800	8.09	230
10/19/2008	Blank2F	2	750	307.04	459.225	2800	8.24	200
10/19/2008	Blank1U	1	750	303.02	459.225	2800	8.18	170
10/26/2008	DRF1	1	900	209.01	459.225	2800	9.09	1350
10/26/2008	DRF2	2	900	225.02	459.225	2800	9.01	1060
10/26/2008	DRF3	3	900	293.04	459.225	2800	8.82	1050
10/26/2008	DRU1	1	900	307.04	459.225	2800	8.99	1060
10/26/2008	DRU2	2	900	291.06	459.225	2800	8.84	1160
10/26/2008	DRU3	3	900	243	459.225	2800	9.08	1090
10/26/2008	BRF1	1	900	107.05	459.225	2800	9.36	1750
10/26/2008	BRF2	2	900	193.02	459.225	2800	9.05	1090
10/26/2008	BRF3	3	900	173.06	459.225	2800	9.25	1810
10/26/2008	BRU1	1	900	97.05	459.225	2800	9.27	2240
10/26/2008	BRU2	2	900	187.01	459.225	2800	9.08	1810
10/26/2008	BRU3	3	900	111.02	459.225	2800	9.31	1850
10/26/2008	WRF1	1	900	329.05	459.225	2800	8.99	1530
10/26/2008	WRF2	2	900	297	459.225	2800	8.76	1240
10/26/2008	WRF3	3	900	145.02	459.225	2800	9.1	1780
10/26/2008	WRU1	1	900	173.06	459.225	2800	9.05	1700
10/26/2008	WRU2	2	900	163.02	459.225	2800	9.06	1530
10/26/2008	WRU3	3	900	217.02	459.225	2800	9.06	1500
10/26/2008	RRF1	1	900	153	459.225	2800	8.49	140
10/26/2008	RRF2	2	900	213	459.225	2800	8.43	160
10/26/2008	RRF3	3	900	149.03	459.225	2800	8.38	180
10/26/2008	RRU1	1	900	151.05	459.225	2800	8.44	120
10/26/2008	RRU2	2	900	303.02	459.225	2800	8.44	130
10/26/2008	RRU3	3	900	259.03	459.225	2800	8.26	130
10/26/2008	Blank1F	1	900	149.09	459.225	2800	8.37	160
10/26/2008	Blank2F	2	900	239.04	459.225	2800	8.25	150
10/26/2008	Blank1U	1	900	233	459.225	2800	8.24	150

Appendix C. Input and output chemistry for DOC, orthophosphate and bicarbonate

Date	A&M ID	Sample ID	Rep #	Input DOC µg g	Output DOC µg g	Input PO_4-P µg g	Output PO_4-P µg g	Input HCO_3^- µg g	Output HCO_3^- µg g
6/9/2008	876	DRF	1	0.37	5.47	0.02	0.06	145.88	15.47
6/9/2008	877	DRF	2	0.37	5.53	0.02	0.04	145.88	11.44
6/9/2008	878	DRF	3	0.37	2.94	0.02	0.03	145.88	11.22
6/9/2008	879	DRU	1	0.37	3.51	0.02	0.02	145.88	8.44
6/9/2008	880	DRU	2	0.37	3.74	0.02	0.06	145.88	20.92
6/9/2008	881	DRU	3	0.37	1.34	0.02	0.02	145.88	7.29
6/9/2008	882	BRF	1	0.13	5.70	0.21	0.11	91.57	20.53
6/9/2008	883	BRF	2	0.13	3.76	0.21	0.09	91.57	22.11
6/9/2008	884	BRF	3	0.13	5.74	0.21	0.04	91.57	22.05
6/9/2008	885	BRU	1	0.13	3.19	0.21	0.01	91.57	8.64
6/9/2008	886	BRU	2	0.13	4.65	0.21	0.02	91.57	21.74
6/9/2008	887	BRU	3	0.13	2.59	0.21	0.03	91.57	34.29
6/9/2008	888	WRF	1	21.47	3.22	0.07	0.03	123.83	21.44
6/9/2008	889	WRF	2	21.47	3.41	0.07	0.01	123.83	11.87
6/9/2008	890	WRF	3	21.47	4.64	0.07	0.02	123.83	17.23
6/9/2008	891	WRU	1	21.47	5.88	0.07	0.02	123.83	12.53
6/9/2008	892	WRU	2	21.47	3.25	0.07	0.01	123.83	13.03
6/9/2008	893	WRU	3	21.47	6.73	0.07	0.03	123.83	28.29
6/9/2008	894	RRF	1	1.17	3.77	0.02	0.03	5.71	10.68
6/9/2008	895	RRF	2	1.17	1.22	0.02	0.02	5.71	5.41
6/9/2008	896	RRF	3	1.17	0.11	0.02	0.01	5.71	5.20
6/9/2008	897	RRU	1	1.17	4.59	0.02	0.02	5.71	6.88
6/9/2008	898	RRU	2	1.17	3.80	0.02	0.02	5.71	5.59
6/9/2008	899	RRU	3	1.17	3.49	0.02	0.01	5.71	5.47
6/9/2008	900	BLANK F	1	1.17	3.22	0.02	0.04	5.71	9.56

6/9/2008	901	BLANK F	2	1.59	4.41	0.03	0.06	7.76	21.59
6/9/2008	902	BLANK U	1	1.59	10.47	0.03	0.03	7.76	13.76
6/16/2008	987	DRF	1	0.37	3.64	0.02	0.08	145.88	24.88
6/16/2008	988	DRF	2	0.37	1.75	0.02	0.05	145.88	7.52
6/16/2008	989	DRF	3	0.37	3.44	0.02	0.01	145.88	17.16
6/16/2008	990	DRU	1	0.37	2.81	0.02	0.02	145.88	14.31
6/16/2008	991	DRU	2	0.37	2.50	0.02	0.05	145.88	15.67
6/16/2008	992	DRU	3	0.37	1.27	0.02	0.04	145.88	11.44
6/16/2008	993	BRF	1	0.13	5.53	0.21	0.16	123.83	19.41
6/16/2008	994	BRF	2	0.13	5.40	0.21	0.11	123.83	27.25
6/16/2008	995	BRF	3	0.13	4.72	0.21	0.08	123.83	22.28
6/16/2008	996	BRU	1	0.13	5.62	0.21	0.02	123.83	20.69
6/16/2008	997	BRU	2	0.13	3.12	0.21	0.03	123.83	17.86
6/16/2008	998	BRU	3	0.13	3.65	0.21	0.09	123.83	13.02
6/16/2008	999	WRF	1	21.47	4.45	0.07	0.07	91.57	28.32
6/16/2008	1000	WRF	2	21.47	3.29	0.07	0.04	91.57	21.28
6/16/2008	1001	WRF	3	21.47	4.31	0.07	0.05	91.57	17.10
6/16/2008	1002	WRU	1	21.47	3.39	0.07	0.03	91.57	13.53
6/16/2008	1003	WRU	2	21.47	3.28	0.07	0.02	91.57	14.59
6/16/2008	1004	WRU	3	21.47	5.29	0.07	0.05	91.57	28.93
6/16/2008	1005	RRF	1	1.18	3.47	0.02	0.02	5.71	3.75
6/16/2008	1006	RRF	2	1.18	1.97	0.02	0.02	5.71	8.43
6/16/2008	1007	RRF	3	1.18	1.14	0.02	0.02	5.71	5.25
6/16/2008	1008	RRU	1	1.18	3.95	0.02	0.03	5.71	6.95
6/16/2008	1009	RRU	2	1.18	2.86	0.02	0.03	5.71	8.49
6/16/2008	1010	RRU	3	1.18	2.17	0.02	0.02	5.71	4.73
6/16/2008	1011	BLANK F	1	1.18	1.47	0.02	0.04	5.71	4.98
6/16/2008	1012	BLANK F	2	1.18	1.53	0.02	0.02	5.71	5.66
6/16/2008	1013	BLANK U	1	1.18	1.62	0.02	0.02	5.71	8.16
6/23/2008	1045	DRF	1	0.37	4.08	0.02	0.09	145.88	34.58
6/23/2008	1046	DRF	2	0.37	4.91	0.02	0.09	145.88	29.91

6/23/2008	1047	DRF	3	0.37	4.50	0.02	0.00	145.88	22.08
6/23/2008	1048	DRU	1	0.37	4.97	0.02	0.07	145.88	27.48
6/23/2008	1049	DRU	2	0.37	5.06	0.02	0.07	145.88	29.08
6/23/2008	1050	DRU	3	0.37	4.80	0.02	0.06	145.88	23.72
6/23/2008	1051	BRF	1	0.13	5.35	0.21	0.13	123.83	37.53
6/23/2008	1052	BRF	2	0.13	3.91	0.21	0.11	123.83	23.64
6/23/2008	1053	BRF	3	0.13	3.86	0.21	0.08	123.83	17.41
6/23/2008	1054	BRU	1	0.13	1.69	0.21	0.02	123.83	36.84
6/23/2008	1055	BRU	2	0.13	4.19	0.21	0.03	123.83	30.79
6/23/2008	1056	BRU	3	0.13	2.68	0.21	0.05	123.83	23.09
6/23/2008	1057	WRF	1	21.47	1.89	0.07	0.05	91.57	29.72
6/23/2008	1058	WRF	2	21.47	3.63	0.07	0.05	91.57	17.88
6/23/2008	1059	WRF	3	21.47	3.04	0.07	0.05	91.57	14.72
6/23/2008	1060	WRU	1	21.47	4.27	0.07	0.04	91.57	34.34
6/23/2008	1061	WRU	2	21.47	2.15	0.07	0.03	91.57	4.71
6/23/2008	1062	WRU	3	21.47	1.32	0.07	0.04	91.57	14.88
6/23/2008	1063	RRF	1	1.17	2.52	0.02	0.03	5.71	11.79
6/23/2008	1064	RRF	2	1.17	0.55	0.02	0.02	5.71	6.59
6/23/2008	1065	RRF	3	1.17	3.22	0.02	0.01	5.71	5.09
6/23/2008	1066	RRU	1	1.17	1.33	0.02	0.03	5.71	8.18
6/23/2008	1067	RRU	2	1.17	2.22	0.02	0.02	5.71	4.41
6/23/2008	1068	RRU	3	1.17	1.55	0.02	0.02	5.71	5.46
6/23/2008	1069	BLANK F	1	1.17	2.97	0.02	0.04	5.71	8.56
6/23/2008	1070	BLANK F	2	1.17	2.75	0.02	0.04	5.71	7.05
6/23/2008	1071	BLANK U	1	1.17	1.39	0.02	0.03	5.71	25.15
6/30/2008	1073	DRF	1	0.37	4.10	0.02	0.07	145.88	29.13
6/30/2008	1074	DRF	2	0.37	5.89	0.02	0.08	145.88	29.83
6/30/2008	1075	DRF	3	0.37	5.48	0.02	0.06	145.88	22.95
6/30/2008	1076	DRU	1	0.37	6.92	0.02	0.09	145.88	28.79
6/30/2008	1077	DRU	2	0.37	6.96	0.02	0.10	145.88	29.27
6/30/2008	1078	DRU	3	0.37	1.79	0.02	0.05	145.88	23.09

6/30/2008	1079	BRF	1	0.13	2.96	0.21	0.08	123.83	17.35
6/30/2008	1080	BRF	2	0.13	2.73	0.21	0.08	123.83	17.77
6/30/2008	1081	BRF	3	0.13	9.57	0.21	0.04	123.83	33.52
6/30/2008	1082	BRU	1	0.13	4.35	0.21	0.04	123.83	47.87
6/30/2008	1083	BRU	2	0.13	2.66	0.21	0.02	123.83	43.84
6/30/2008	1084	BRU	3	0.13	4.15	0.21	0.07	123.83	35.88
6/30/2008	1085	WRF	1	21.47	10.16	0.07	0.05	91.57	38.97
6/30/2008	1086	WRF	2	21.47	6.60	0.07	0.08	91.57	37.45
6/30/2008	1087	WRF	3	21.47	7.08	0.07	0.08	91.57	39.11
6/30/2008	1088	WRU	1	21.47	5.93	0.07	0.06	91.57	38.72
6/30/2008	1089	WRU	2	21.47	4.81	0.07	0.06	91.57	37.57
6/30/2008	1090	WRU	3	21.47	4.49	0.07	0.07	91.57	39.01
6/30/2008	1091	RRF	1	1.17	3.54	0.02	0.02	5.71	9.88
6/30/2008	1092	RRF	2	1.17	3.19	0.02	0.02	5.71	8.03
6/30/2008	1093	RRF	3	1.17	2.89	0.02	0.01	5.71	6.52
6/30/2008	1094	RRU	1	1.17	2.81	0.02	0.03	5.71	11.92
6/30/2008	1095	RRU	2	1.17	4.87	0.02	0.02	5.71	7.89
6/30/2008	1096	RRU	3	1.17	2.32	0.02	0.02	5.71	8.63
6/30/2008	1097	BLANK F	1	1.17	1.29	0.02	0.03	5.71	9.69
6/30/2008	1098	BLANK F	2	1.17	4.23	0.02	0.03	5.71	7.07
6/30/2008	1099	BLANK U	1	1.17	3.98	0.02	0.03	5.71	10.50
7/7/2008	1119	DRF	1	0.37	6.68	0.02	0.07	124.93	16.65
7/7/2008	1120	DRF	2	0.37	4.43	0.02	0.07	124.93	15.26
7/7/2008	1121	DRF	3	0.37	4.23	0.02	0.07	124.93	15.65
7/7/2008	1122	DRU	1	0.37	5.07	0.02	0.11	124.93	15.70
7/7/2008	1123	DRU	2	0.37	9.24	0.02	0.11	124.93	14.90
7/7/2008	1124	DRU	3	0.37	4.26	0.02	0.07	124.93	15.77
7/7/2008	1125	BRF	1	7.51	10.05	0.10	0.19	137.87	16.70
7/7/2008	1126	BRF	2	7.51	2.64	0.10	0.12	137.87	35.77
7/7/2008	1127	BRF	3	7.51	4.85	0.10	0.10	137.87	16.99
7/7/2008	1128	BRU	1	7.51	5.20	0.10	0.06	137.87	48.72

7/7/2008	1129	BRU	2	7.51	6.43	0.10	0.04	137.87	35.34
7/7/2008	1130	BRU	3	7.51	3.28	0.10	0.08	137.87	36.10
7/7/2008	1131	WRF	1	24.86	4.57	0.06	0.07	272.19	39.60
7/7/2008	1132	WRF	2	24.86	7.42	0.06	0.07	272.19	38.12
7/7/2008	1133	WRF	3	24.86	5.52	0.06	0.06	272.19	34.39
7/7/2008	1134	WRU	1	24.86	6.71	0.06	0.08	272.19	38.97
7/7/2008	1135	WRU	2	24.86	5.96	0.06	0.05	272.19	19.49
7/7/2008	1136	WRU	3	24.86	5.86	0.06	0.07	272.19	35.28
7/7/2008	1137	RRF	1	1.93	3.74	0.01	0.03	9.90	10.24
7/7/2008	1138	RRF	2	1.93	3.97	0.01	0.02	9.90	9.66
7/7/2008	1139	RRF	3	1.93	3.34	0.01	0.02	9.90	7.28
7/7/2008	1140	RRU	1	1.93	3.90	0.01	0.04	9.90	11.21
7/7/2008	1141	RRU	2	1.93	3.87	0.01	0.02	9.90	9.16
7/7/2008	1142	RRU	3	1.93	2.44	0.01	0.03	9.90	10.49
7/7/2008	1143	BLANK F	1	1.93	2.11	0.01	0.04	9.90	9.22
7/7/2008	1144	BLANK F	2	1.93	1.75	0.01	0.03	9.90	6.76
7/7/2008	1145	BLANK U	1	1.93	1.71	0.01	0.04	9.90	10.71
7/14/2008	1248	DRF	1	0.07	0.15	0.06	0.08	113.96	30.61
7/14/2008	1249	DRF	2	0.07	4.79	0.06	0.11	113.96	30.98
7/14/2008	1250	DRF	3	0.07	5.76	0.06	0.09	113.96	31.31
7/14/2008	1251	DRU	1	0.07	5.04	0.06	0.11	113.96	31.37
7/14/2008	1252	DRU	2	0.07	6.77	0.06	0.09	113.96	17.12
7/14/2008	1253	DRU	3	0.07	0.78	0.06	0.06	113.96	25.36
7/14/2008	1254	BRF	1	3.13	8.83	0.06	0.18	134.75	49.14
7/14/2008	1255	BRF	2	3.13	5.14	0.06	0.13	134.75	48.24
7/14/2008	1256	BRF	3	3.13	6.93	0.06	0.12	134.75	44.43
7/14/2008	1257	BRU	1	3.13	9.27	0.06	0.07	134.75	53.78
7/14/2008	1258	BRU	2	3.13	7.28	0.06	0.05	134.75	50.37
7/14/2008	1259	BRU	3	3.13	4.01	0.06	0.08	134.75	43.57
7/14/2008	1260	WRF	1	11.38	5.70	0.01	0.07	135.53	53.95
7/14/2008	1261	WRF	2	11.38	10.15	0.01	0.08	135.53	50.80

7/14/2008	1262	WRF	3	11.38	12.50	0.01	0.08	135.53	64.05
7/14/2008	1263	WRU	1	11.38	11.11	0.01	0.07	135.53	19.42
7/14/2008	1264	WRU	2	11.38	9.37	0.01	0.07	135.53	36.44
7/14/2008	1265	WRU	3	11.38	7.03	0.01	0.10	135.53	38.64
7/14/2008	1266	RRF	1	0.46	3.19	0.00	0.04	10.39	7.88
7/14/2008	1267	RRF	2	0.46	2.70	0.00	0.02	10.39	9.78
7/14/2008	1268	RRF	3	0.46	3.31	0.00	0.02	10.39	12.37
7/14/2008	1269	RRU	1	0.46	3.74	0.00	0.04	10.39	12.37
7/14/2008	1270	RRU	2	0.46	4.00	0.00	0.03	10.39	8.33
7/14/2008	1271	RRU	3	0.46	0.79	0.00	0.03	10.39	7.73
7/14/2008	1272	BLANK F	1	0.46	3.02	0.00	0.04	10.39	7.44
7/14/2008	1273	BLANK F	2	0.46	3.42	0.00	0.03	10.39	7.07
7/14/2008	1274	BLANK U	1	0.46	2.15	0.00	0.03	10.39	8.36
7/21/2008	1335	DRF	1	0.25	3.15	0.05	0.06	116.58	16.01
7/21/2008	1336	DRF	2	0.25	4.33	0.05	0.07	116.58	17.49
7/21/2008	1337	DRF	3	0.25	4.53	0.05	0.06	116.58	18.43
7/21/2008	1332	DRU	1	0.25	5.09	0.05	0.07	116.58	18.59
7/21/2008	1333	DRU	2	0.25	3.11	0.05	0.06	116.58	16.32
7/21/2008	1334	DRU	3	0.25	1.23	0.05	0.04	116.58	13.66
7/21/2008	1329	BRF	1	3.57	4.81	0.06	0.11	120.51	24.16
7/21/2008	1330	BRF	2	3.57	2.99	0.06	0.07	120.51	23.04
7/21/2008	1331	BRF	3	3.57	4.01	0.06	0.08	120.51	23.48
7/21/2008	1326	BRU	1	3.57	5.17	0.06	0.03	120.51	27.90
7/21/2008	1327	BRU	2	3.57	5.06	0.06	0.03	120.51	27.10
7/21/2008	1328	BRU	3	3.57	2.32	0.06	0.05	120.51	23.00
7/21/2008	1325	WRF	2	8.94	6.76	0.00	0.07	124.53	31.02
7/21/2008	1345	WRF	3	8.94	5.69	0.00	0.06	124.53	37.01
7/21/2008	1346	WRF	1	8.94	3.29	0.00	0.04	124.53	29.12
7/21/2008	1342	WRU	1	8.94	3.79	0.00	0.06	124.53	28.15
7/21/2008	1343	WRU	2	8.94	4.84	0.00	0.05	124.53	26.39
7/21/2008	1344	WRU	3	8.94	4.93	0.00	0.06	124.53	24.57

7/21/2008	1347	RRF	2	1.57	1.10	0.00	0.01	9.37	4.79
7/21/2008	1348	RRF	1	1.57	1.85	0.00	0.02	9.37	5.33
7/21/2008	1349	RRF	3	1.57	1.60	0.00	0.01	9.37	6.25
7/21/2008	1324	RRU	1	1.57	0.00	0.00	0.00	9.37	0.00
7/21/2008	1341	RRU	2	1.57	1.80	0.00	0.02	9.37	4.96
7/21/2008	1350	RRU	3	1.57	1.00	0.00	0.02	9.37	3.74
7/21/2008	1338	BLANK F	1	1.57	0.76	0.00	0.02	9.37	3.64
7/21/2008	1339	BLANK F	2	1.57	0.98	0.00	0.02	9.37	4.18
7/21/2008	1340	BLANK U	1	1.57	1.06	0.00	0.02	9.37	4.27
7/29/2008	1358	DRF	1	0.71	2.54	0.05	0.05	106.49	7.95
7/29/2008	1359	DRF	2	0.71	3.14	0.05	0.05	106.49	8.12
7/29/2008	1360	DRF	3	0.71	2.92	0.05	0.05	106.49	7.66
7/29/2008	1361	DRU	1	0.71	2.92	0.05	0.07	106.49	7.68
7/29/2008	1362	DRU	2	0.71	3.30	0.05	0.05	106.49	7.73
7/29/2008	1363	DRU	3	0.71	1.32	0.05	0.04	106.49	13.02
7/29/2008	1364	BRF	1	26.92	4.32	0.17	0.09	122.57	25.15
7/29/2008	1365	BRF	2	26.92	3.53	0.17	0.08	122.57	27.28
7/29/2008	1366	BRF	3	26.92	3.33	0.17	0.06	122.57	17.58
7/29/2008	1367	BRU	1	26.92	5.36	0.17	0.04	122.57	27.93
7/29/2008	1368	BRU	2	26.92	5.27	0.17	0.03	122.57	29.97
7/29/2008	1369	BRU	3	26.92	3.12	0.17	0.04	122.57	24.13
7/29/2008	1370	WRF	1	27.70	3.94	0.01	0.05	116.43	27.52
7/29/2008	1371	WRF	2	27.70	6.99	0.01	0.07	116.43	10.91
7/29/2008	1372	WRF	3	27.70	5.11	0.01	0.05	116.43	21.91
7/29/2008	1373	WRU	1	27.70	3.78	0.01	0.06	116.43	30.23
7/29/2008	1374	WRU	2	27.70	4.68	0.01	0.05	116.43	27.34
7/29/2008	1375	WRU	3	27.70	3.38	0.01	0.04	116.43	10.99
7/29/2008	1376	RRF	1	5.26	1.71	0.03	0.02	10.24	6.12
7/29/2008	1377	RRF	2	5.26	1.01	0.03	0.01	10.24	4.55
7/29/2008	1378	RRF	3	5.26	1.60	0.03	0.01	10.24	5.75
7/29/2008	1379	RRU	1	5.26	1.56	0.03	0.02	10.24	5.28

7/29/2008	1380	RRU	2	5.26	2.24	0.03	0.02	10.24	6.26
7/29/2008	1381	RRU	3	5.26	1.29	0.03	0.02	10.24	6.44
7/29/2008	1382	BLANK F	1	5.26	0.77	0.03	0.02	10.24	2.74
7/29/2008	1383	BLANK F	2	5.26	1.15	0.03	0.02	10.24	3.23
7/29/2008	1384	BLANK U	1	5.26	0.48	0.03	0.02	10.24	4.19
8/4/2008	1420	DRF1	1	0.50	6.77	0.07	0.14	120.01	34.05
8/4/2008	1421	DRF2	2	0.50	3.95	0.07	0.11	120.01	33.03
8/4/2008	1422	DRF3	3	0.50	4.96	0.07	0.12	120.01	35.69
8/4/2008	1423	DRU1	1	0.50	6.62	0.07	0.15	120.01	41.95
8/4/2008	1424	DRU2	2	0.50	7.90	0.07	0.12	120.01	39.53
8/4/2008	1425	DRU3	3	0.50	2.76	0.07	0.09	120.01	32.37
8/4/2008	1426	BRF1	1	14.96	9.77	0.95	0.27	231.82	50.73
8/4/2008	1427	BRF2	2	14.96	4.88	0.95	0.18	231.82	33.28
8/4/2008	1428	BRF3	3	14.96	7.67	0.95	0.22	231.82	45.91
8/4/2008	1429	BRU1	1	14.96	7.95	0.95	0.11	231.82	44.23
8/4/2008	1430	BRU2	2	14.96	9.47	0.95	0.09	231.82	49.05
8/4/2008	1431	BRU3	3	14.96	6.87	0.95	0.13	231.82	39.35
8/4/2008	1432	WRF1	1	23.62	10.17	0.01	0.07	119.96	48.85
8/4/2008	1433	WRF2	2	23.62	10.28	0.01	0.09	119.96	45.26
8/4/2008	1434	WRF3	3	23.62	12.64	0.01	0.08	119.96	49.76
8/4/2008	1435	WRU1	1	23.62	13.16	0.01	0.11	119.96	53.70
8/4/2008	1436	WRU2	2	23.62	7.56	0.01	0.06	119.96	46.77
8/4/2008	1437	WRU3	3	23.62	10.05	0.01	0.06	119.96	33.80
8/4/2008	1438	RRF1	1	0.50	4.27	0.00	0.04	9.49	13.90
8/4/2008	1439	RRF2	2	0.50	1.73	0.00	0.02	9.49	7.02
8/4/2008	1440	RRF3	3	0.50	4.08	0.00	0.02	9.49	18.50
8/4/2008	1441	RRU1	1	0.50	2.06	0.00	0.02	9.49	10.28
8/4/2008	1442	RRU2	2	0.50	5.09	0.00	0.04	9.49	10.29
8/4/2008	1443	RRU3	3	0.50	3.04	0.00	0.03	9.49	13.93
8/4/2008	1444	B1F	1	0.50	4.02	0.00	0.06	9.49	17.72
8/4/2008	1445	B2F	2	0.50	3.17	0.00	0.03	9.49	6.51

8/4/2008	1446	B1U	1	0.50	2.46	0.00	0.03	9.49	6.64
8/11/2008	1608	DRF1	1	0.36	8.69	0.07	0.16	140.38	38.29
8/11/2008	1609	DRF2	2	0.36	3.39	0.07	0.11	140.38	23.85
8/11/2008	1610	DRF3	3	0.36	4.41	0.07	0.09	140.38	19.07
8/11/2008	1611	DRU1	1	0.36	9.52	0.07	0.20	140.38	47.86
8/11/2008	1612	DRU2	2	0.36	4.21	0.07	0.08	140.38	11.86
8/11/2008	1613	DRU3	3	0.36	4.13	0.07	0.10	140.38	32.03
8/11/2008	1614	BRF1	1	9.67	8.85	1.26	0.22	238.17	30.67
8/11/2008	1615	BRF2	2	9.67	6.62	1.26	0.33	238.17	65.50
8/11/2008	1616	BRF3	3	9.67	11.38	1.26	0.29	238.17	63.65
8/11/2008	1617	BRU1	1	9.67	13.73	1.26	0.21	238.17	66.66
8/11/2008	1618	BRU2	2	9.67	7.12	1.26	0.11	238.17	59.52
8/11/2008	1619	BRU3	3	9.67	8.88	1.26	0.17	238.17	50.56
8/11/2008	1620	WRF1	1	15.66	10.07	0.01	0.13	134.35	67.01
8/11/2008	1621	WRF2	2	15.66	5.76	0.01	0.06	134.35	17.47
8/11/2008	1622	WRF3	3	15.66	9.52	0.01	0.10	134.35	40.82
8/11/2008	1623	WRU1	1	15.66	12.40	0.01	0.11	134.35	45.52
8/11/2008	1624	WRU2	2	15.66	10.11	0.01	0.09	134.35	51.94
8/11/2008	1625	WRU3	3	15.66	10.57	0.01	0.10	134.35	42.83
8/11/2008	1626	RRF1	1	3.57	2.40	0.01	0.04	10.18	8.20
8/11/2008	1627	RRF2	2	3.57	0.94	0.01	0.01	10.18	3.31
8/11/2008	1628	RRF3	3	3.57	2.68	0.01	0.02	10.18	7.64
8/11/2008	1629	RRU1	1	3.57	2.78	0.01	0.04	10.18	7.37
8/11/2008	1630	RRU2	2	3.57	6.10	0.01	0.05	10.18	10.75
8/11/2008	1631	RRU3	3	3.57	2.19	0.01	0.03	10.18	5.18
8/11/2008	1632	Blank1F	1	3.57	3.06	0.01	0.05	10.18	6.23
8/11/2008	1633	Blank2F	2	3.57	3.91	0.01	0.05	10.18	9.45
8/11/2008	1634	Blank1U	1	3.57	3.21	0.01	0.04	10.18	8.16
8/18/2008	1640	DRF1	1	0.25	6.79	0.04	0.13	84.10	24.14
8/18/2008	1641	DRF2	2	0.25	5.87	0.04	0.15	84.10	35.44
8/18/2008	1642	DRF3	3	0.25	10.51	0.04	0.14	84.10	40.64

8/18/2008	1643	DRU1	1	0.25	6.66	0.04	0.13	84.10	33.08
8/18/2008	1644	DRU2	2	0.25	10.04	0.04	0.16	84.10	38.55
8/18/2008	1645	DRU3	3	0.25	3.65	0.04	0.13	84.10	43.42
8/18/2008	1646	BRF1	1	3.85	14.61	0.60	0.34	97.87	31.91
8/18/2008	1647	BRF2	2	3.85	6.97	0.60	0.26	97.87	30.32
8/18/2008	1648	BRF3	3	3.85	16.12	0.60	0.33	97.87	49.83
8/18/2008	1649	BRU1	1	3.85	15.89	0.60	0.35	97.87	51.64
8/18/2008	1650	BRU2	2	3.85	9.11	0.60	0.10	97.87	32.61
8/18/2008	1651	BRU3	3	3.85	9.44	0.60	0.18	97.87	41.07
8/18/2008	1652	WRF1	1	7.21	12.04	0.01	0.15	87.45	51.17
8/18/2008	1653	WRF2	2	7.21	24.48	0.01	0.23	87.45	47.11
8/18/2008	1654	WRF3	3	7.21	16.84	0.01	0.21	87.45	51.05
8/18/2008	1655	WRU1	1	7.21	14.58	0.01	0.16	87.45	45.30
8/18/2008	1656	WRU2	2	7.21	16.66	0.01	0.14	87.45	63.03
8/18/2008	1657	WRU3	3	7.21	18.75	0.01	0.18	87.45	60.56
8/18/2008	1658	RRF1	1	2.17	3.35	0.02	0.05	7.24	9.64
8/18/2008	1659	RRF2	2	2.17	1.94	0.02	0.03	7.24	8.35
8/18/2008	1660	RRF3	3	2.17	3.00	0.02	0.03	7.24	11.18
8/18/2008	1661	RRU1	1	2.17	3.68	0.02	0.05	7.24	10.79
8/18/2008	1662	RRU2	2	2.17	4.63	0.02	0.04	7.24	7.90
8/18/2008	1663	RRU3	3	2.17	1.55	0.02	0.03	7.24	7.63
8/18/2008	1664	B1F	1	2.17	2.20	0.02	0.05	7.24	4.37
8/18/2008	1665	B2F	2	2.17	2.75	0.02	0.04	7.24	17.54
8/18/2008	1666	B1U	1	2.17	2.89	0.02	0.05	7.24	10.42
8/25/2008	1732	DRF1	1	0.13	5.14	0.05	0.11	72.64	26.54
8/25/2008	1733	DRF2	2	0.13	15.22	0.05	0.13	72.64	29.95
8/25/2008	1734	DRF3	3	0.13	5.11	0.05	0.10	72.64	28.73
8/25/2008	1735	DRU1	1	0.13	5.95	0.05	0.16	72.64	35.64
8/25/2008	1736	DRU2	2	0.13	5.96	0.05	0.10	72.64	24.34
8/25/2008	1737	DRU3	3	0.13	1.97	0.05	0.09	72.64	34.67
8/25/2008	1738	BRF1	1	1.56	7.61	0.01	0.29	74.37	26.57

8/25/2008	1739	BRF2	2	1.56	6.89	0.01	0.26	74.37	34.37
8/25/2008	1740	BRF3	3	1.56	10.26	0.01	0.31	74.37	38.68
8/25/2008	1741	BRU1	1	1.56	11.10	0.01	0.28	74.37	42.12
8/25/2008	1742	BRU2	2	1.56	5.98	0.01	0.14	74.37	28.56
8/25/2008	1743	BRU3	3	1.56	5.45	0.01	0.24	74.37	30.77
8/25/2008	1744	WRF1	1	12.11	5.72	0.00	0.07	73.04	33.74
8/25/2008	1745	WRF2	2	12.11	8.56	0.00	0.09	73.04	28.37
8/25/2008	1746	WRF3	3	12.11	10.21	0.00	0.14	73.04	44.41
8/25/2008	1747	WRU1	1	12.11	8.18	0.00	0.13	73.04	46.94
8/25/2008	1748	WRU2	2	12.11	7.23	0.00	0.08	73.04	33.58
8/25/2008	1749	WRU3	3	12.11	4.82	0.00	0.07	73.04	29.20
8/25/2008	1750	RRF1	1	0.27	2.26	0.00	0.03	5.81	6.95
8/25/2008	1751	RRF2	2	0.27	1.52	0.00	0.02	5.81	4.78
8/25/2008	1752	RRF3	3	0.27	1.64	0.00	0.02	5.81	5.47
8/25/2008	1753	RRU1	1	0.27	1.69	0.00	0.03	5.81	7.88
8/25/2008	1754	RRU2	2	0.27	1.95	0.00	0.02	5.81	10.49
8/25/2008	1755	RRU3	3	0.27	1.19	0.00	0.02	5.81	4.90
8/25/2008	1756	Blank1F	1	0.27	1.31	0.00	0.03	5.81	6.13
8/25/2008	1757	Blank2F	2	0.27	1.81	0.00	0.03	5.81	3.93
8/25/2008	1758	Blank1U	1	0.27	1.09	0.00	0.03	5.81	4.16
9/1/2008	1830	DRF1	1	0.22	3.37	0.03	0.09	81.10	25.19
9/1/2008	1831	DRF2	2	0.22	3.61	0.03	0.10	81.10	26.81
9/1/2008	1832	DRF3	3	0.22	2.74	0.03	0.11	81.10	30.19
9/1/2008	1833	DRU1	1	0.22	3.25	0.03	0.12	81.10	29.90
9/1/2008	1834	DRU2	2	0.22	9.06	0.03	0.19	81.10	46.11
9/1/2008	1835	DRU3	3	0.22	2.61	0.03	0.12	81.10	31.90
9/1/2008	1836	BRF1	1	1.64	15.90	0.01	0.47	82.29	65.75
9/1/2008	1837	BRF2	2	1.64	10.76	0.01	0.41	82.29	58.24
9/1/2008	1838	BRF3	3	1.64	14.90	0.01	0.28	82.29	38.69
9/1/2008	1839	BRU1	1	1.64	14.97	0.01	0.22	82.29	52.58
9/1/2008	1840	BRU2	2	1.64	8.35	0.01	0.08	82.29	30.84

9/1/2008	1841	BRU3	3	1.64	8.88	0.01	0.32	82.29	52.76
9/1/2008	1842	WRF1	1	7.86	8.21	0.01	0.08	82.99	35.44
9/1/2008	1843	WRF2	2	7.86	4.90	0.01	0.09	82.99	38.36
9/1/2008	1844	WRF3	3	7.86	11.46	0.01	0.22	82.99	58.61
9/1/2008	1845	WRU1	1	7.86	9.73	0.01	0.12	82.99	48.82
9/1/2008	1846	WRU2	2	7.86	7.98	0.01	0.10	82.99	45.71
9/1/2008	1847	WRU3	3	7.86	12.54	0.01	0.12	82.99	52.60
9/1/2008	1848	RRF1	1	2.34	3.97	0.00	0.06	5.41	17.02
9/1/2008	1849	RRF2	2	2.34	2.87	0.00	0.02	5.41	9.10
9/1/2008	1850	RRF3	3	2.34	2.44	0.00	0.02	5.41	8.89
9/1/2008	1851	RRU1	1	2.34	2.32	0.00	0.04	5.41	6.99
9/1/2008	1852	RRU2	2	2.34	2.08	0.00	0.03	5.41	12.97
9/1/2008	1853	RRU3	3	2.34	2.52	0.00	0.03	5.41	7.54
9/1/2008	1854	Blank1F	1	2.34	1.44	0.00	0.03	5.41	12.61
9/1/2008	1855	Blank2F	2	2.34	1.67	0.00	0.05	5.41	12.70
9/1/2008	1856	Blank1U	1	2.34	1.37	0.00	0.03	5.41	15.11
9/8/2008	1961	DRF1	2	0.10	4.78	0.03	0.12	86.16	31.08
9/8/2008	1962	DRF2	3	0.10	5.37	0.03	0.18	86.16	40.08
9/8/2008	1963	DRF3	1	0.10	4.62	0.03	0.16	86.16	30.38
9/8/2008	1964	DRU1	2	0.10	6.59	0.03	0.21	86.16	38.13
9/8/2008	1965	DRU2	3	0.10	8.09	0.03	0.18	86.16	36.74
9/8/2008	1966	DRU3	1	0.10	2.58	0.03	0.09	86.16	26.64
9/8/2008	1967	BRF1	2	0.67	18.07	0.00	0.43	86.47	55.82
9/8/2008	1968	BRF2	3	0.67	9.55	0.00	0.35	86.47	49.00
9/8/2008	1969	BRF3	1	0.67	12.11	0.00	0.27	86.47	38.67
9/8/2008	1970	BRU1	2	0.67	12.86	0.00	0.18	86.47	46.03
9/8/2008	1971	BRU2	3	0.67	11.65	0.00	0.16	86.47	50.73
9/8/2008	1972	BRU3	1	0.67	8.93	0.00	0.20	86.47	40.58
9/8/2008	1973	WRF1	2	8.39	11.85	0.01	0.13	85.92	47.26
9/8/2008	1974	WRF2	3	8.39	13.27	0.01	0.13	85.92	45.08
9/8/2008	1975	WRF3	1	8.39	8.85	0.01	0.10	85.92	37.09

9/8/2008	1976	WRU1	2	8.39	11.70	0.01	0.13	85.92	45.09
9/8/2008	1977	WRU2	3	8.39	16.02	0.01	0.11	85.92	43.01
9/8/2008	1978	WRU3	1	8.39	9.15	0.01	0.11	85.92	42.17
9/8/2008	1979	RRF1	2	0.42	2.94	0.01	0.03	4.67	7.57
9/8/2008	1980	RRF2	3	0.42	5.08	0.01	0.02	4.67	6.58
9/8/2008	1981	RRF3	1	0.42	2.94	0.01	0.02	4.67	5.56
9/8/2008	1982	RRU1	2	0.42	2.18	0.01	0.03	4.67	3.19
9/8/2008	1983	RRU2	3	0.42	3.13	0.01	0.03	4.67	9.14
9/8/2008	1984	RRU3	1	0.42	1.41	0.01	0.01	4.67	4.44
9/8/2008	1985	B1F	2	0.42	1.53	0.01	0.04	4.67	3.83
9/8/2008	1986	B2F	1	0.42	2.03	0.01	0.03	4.67	3.50
9/8/2008	1987	B1U	1	0.42	2.42	0.01	0.04	4.67	4.04
9/15/2008	2103	DRF1	1	0.41	4.34	0.04	0.13	78.41	36.80
9/15/2008	2104	DRF2	2	0.41	4.98	0.04	0.16	78.41	38.68
9/15/2008	2105	DRF3	3	0.41	2.66	0.04	0.08	78.41	24.12
9/15/2008	2106	DRU1	1	0.41	3.53	0.04	0.10	78.41	32.91
9/15/2008	2107	DRU2	2	0.41	4.92	0.04	0.11	78.41	28.59
9/15/2008	2108	DRU3	3	0.41	4.89	0.04	0.12	78.41	37.64
9/15/2008	2109	BRF1	1	1.00	16.55	0.01	0.40	78.86	58.85
9/15/2008	2110	BRF2	2	1.00	12.05	0.01	0.30	78.86	59.50
9/15/2008	2111	BRF3	3	1.00	14.73	0.01	0.32	78.86	54.91
9/15/2008	2112	BRU1	1	1.00	11.50	0.01	0.14	78.86	50.36
9/15/2008	2113	BRU2	2	1.00	9.15	0.01	0.08	78.86	37.89
9/15/2008	2114	BRU3	3	1.00	9.00	0.01	0.21	78.86	61.03
9/15/2008	2115	WRF1	1	11.53	9.92	0.00	0.11	78.91	45.02
9/15/2008	2116	WRF2	2	11.53	10.85	0.00	0.15	78.91	56.22
9/15/2008	2117	WRF3	3	11.53	9.20	0.00	0.12	78.91	47.60
9/15/2008	2118	WRU1	1	11.53	9.12	0.00	0.11	78.91	43.67
9/15/2008	2119	WRU2	2	11.53	10.72	0.00	0.10	78.91	49.98
9/15/2008	2120	WRU3	3	11.53	8.48	0.00	0.13	78.91	69.00
9/15/2008	2121	RRF1	1	2.45	1.74	0.00	0.03	4.66	20.23

9/15/2008	2122	RRF2	2	2.45	3.99	0.00	0.02	4.66	9.46
9/15/2008	2123	RRF3	3	2.45	2.36	0.00	0.02	4.66	18.51
9/15/2008	2124	RRU1	1	2.45	2.07	0.00	0.04	4.66	21.03
9/15/2008	2125	RRU2	2	2.45	2.72	0.00	0.04	4.66	28.14
9/15/2008	2126	RRU3	3	2.45	2.12	0.00	0.03	4.66	8.34
9/15/2008	2127	B1F	1	2.45	1.61	0.00	0.04	4.66	6.40
9/15/2008	2128	B2F	2	2.45	2.51	0.00	0.04	4.66	7.40
9/15/2008	2129	B1U	1	2.45	1.86	0.00	0.04	4.66	25.90
9/22/2008	2193	DRF1	1	0.20	4.81	0.04	0.12	82.74	39.84
9/22/2008	2194	DRF2	2	0.20	4.29	0.04	0.15	82.74	36.54
9/22/2008	2195	DRF3	3	0.20	6.34	0.04	0.14	82.74	32.37
9/22/2008	2196	DRU1	1	0.20	6.38	0.04	0.15	82.74	48.66
9/22/2008	2197	DRU2	2	0.20	11.08	0.04	0.12	82.74	32.13
9/22/2008	2198	DRU3	3	0.20	7.51	0.04	0.11	82.74	43.10
9/22/2008	2199	BRF1	1	0.94	13.41	0.01	0.45	75.44	70.42
9/22/2008	2200	BRF2	2	0.94	11.49	0.01	0.28	75.44	63.71
9/22/2008	2201	BRF3	3	0.94	15.77	0.01	0.31	75.44	57.68
9/22/2008	2202	BRU1	1	0.94	10.17	0.01	0.16	75.44	63.49
9/22/2008	2203	BRU2	2	0.94	13.11	0.01	0.14	75.44	53.67
9/22/2008	2204	BRU3	3	0.94	11.16	0.01	0.19	75.44	59.22
9/22/2008	2205	WRF1	1	6.20	13.82	0.01	0.18	70.79	58.04
9/22/2008	2206	WRF2	2	6.20	6.53	0.01	0.13	70.79	51.37
9/22/2008	2207	WRF3	3	6.20	5.73	0.01	0.08	70.79	30.44
9/22/2008	2208	WRU1	1	6.20	13.57	0.01	0.12	70.79	53.85
9/22/2008	2209	WRU2	2	6.20	18.09	0.01	0.15	70.79	66.83
9/22/2008	2210	WRU3	3	6.20	19.70	0.01	0.15	70.79	56.14
9/22/2008	2211	RRF1	1	2.16	2.65	0.00	0.04	5.11	8.86
9/22/2008	2212	RRF2	2	2.16	13.20	0.00	0.02	5.11	13.21
9/22/2008	2213	RRF3	3	2.16	2.27	0.00	0.02	5.11	20.03
9/22/2008	2214	RRU1	1	2.16	2.60	0.00	0.04	5.11	23.23
9/22/2008	2215	RRU2	2	2.16	2.69	0.00	0.04	5.11	20.19

9/22/2008	2216	RRU3	3	2.16	3.97	0.00	0.03	5.11	15.72
9/22/2008	2217	Blank1F	1	2.16	1.89	0.00	0.03	5.11	7.50
9/22/2008	2218	Blank2F	2	2.16	2.12	0.00	0.04	5.11	16.81
9/22/2008	2219	Blank1U	1	2.16	2.22	0.00	0.04	5.11	9.12
9/29/2008	2252	DRF1	1	0.26	3.08	0.04	0.07	58.33	16.13
9/29/2008	2253	DRF2	2	0.26	4.36	0.04	0.11	58.33	29.92
9/29/2008	2254	DRF3	3	0.26	12.89	0.04	0.18	58.33	45.65
9/29/2008	2255	DRU1	1	0.26	4.06	0.04	0.07	58.33	15.52
9/29/2008	2256	DRU2	2	0.26	8.44	0.04	0.10	58.33	32.28
9/29/2008	2257	DRU3	3	0.26	3.78	0.04	0.08	58.33	30.72
9/29/2008	2258	BRF1	1	2.58	11.74	0.00	0.27	81.27	42.31
9/29/2008	2259	BRF2	2	2.58	5.33	0.00	0.12	81.27	25.10
9/29/2008	2260	BRF3	3	2.58	6.47	0.00	0.09	81.27	29.59
9/29/2008	2261	BRU1	1	2.58	12.58	0.00	0.10	81.27	40.01
9/29/2008	2262	BRU2	2	2.58	8.08	0.00	0.10	81.27	45.29
9/29/2008	2263	BRU3	3	2.58	7.81	0.00	0.11	81.27	35.60
9/29/2008	2264	WRF1	1	8.47	8.89	0.00	0.13	84.10	55.03
9/29/2008	2265	WRF2	2	8.47	10.30	0.00	0.13	84.10	48.34
9/29/2008	2266	WRF3	3	8.47	10.58	0.00	0.20	84.10	55.61
9/29/2008	2267	WRU1	1	8.47	6.08	0.00	0.07	84.10	29.75
9/29/2008	2268	WRU2	2	8.47	13.27	0.00	0.11	84.10	44.85
9/29/2008	2269	WRU3	3	8.47	9.61	0.00	0.11	84.10	41.94
9/29/2008	2270	RRF1	1	2.02	1.91	0.01	0.02	4.39	7.31
9/29/2008	2271	RRF2	2	2.02	4.81	0.01	0.01	4.39	8.39
9/29/2008	2272	RRF3	3	2.02	1.53	0.01	0.01	4.39	6.28
9/29/2008	2273	RRU1	1	2.02	2.21	0.01	0.02	4.39	7.21
9/29/2008	2274	RRU2	2	2.02	2.67	0.01	0.03	4.39	10.15
9/29/2008	2275	RRU3	3	2.02	1.10	0.01	0.01	4.39	5.13
9/29/2008	2276	Blank1F	1	2.02	1.49	0.01	0.03	4.39	6.71
9/29/2008	2277	Blank2F	2	2.02	1.37	0.01	0.03	4.39	8.61
9/29/2008	2278	Blank1U	1	2.02	1.98	0.01	0.03	4.39	6.57

10/5/2008	2434	DRF1	1	0.22	2.08	0.03	0.04	65.06	18.59
10/5/2008	2435	DRF2	2	0.22	3.21	0.03	0.07	65.06	23.31
10/5/2008	2436	DRF3	3	0.22	4.83	0.03	0.08	65.06	19.34
10/5/2008	2437	DRU1	1	0.22	6.50	0.03	0.09	65.06	12.11
10/5/2008	2438	DRU2	2	0.22	3.81	0.03	0.05	65.06	16.64
10/5/2008	2439	DRU3	3	0.22	2.81	0.03	0.06	65.06	24.66
10/5/2008	2440	BRF1	1	1.75	4.17	0.00	0.02	80.33	18.99
10/5/2008	2441	BRF2	2	1.40	5.82	0.00	0.11	64.26	28.41
10/5/2008	2442	BRF3	3	1.75	5.85	0.00	0.12	80.33	13.14
10/5/2008	2443	BRU1	1	1.75	6.21	0.00	0.07	80.33	9.88
10/5/2008	2444	BRU2	2	1.75	5.76	0.00	0.07	80.33	25.80
10/5/2008	2445	BRU3	3	1.75	5.77	0.00	0.08	80.33	34.38
10/5/2008	2446	WRF1	1	6.41	8.15	0.00	0.10	82.09	41.28
10/5/2008	2447	WRF2	2	6.41	7.54	0.00	0.11	82.09	42.58
10/5/2008	2448	WRF3	3	6.41	5.07	0.00	0.08	82.09	25.29
10/5/2008	2449	WRU1	1	6.41	3.89	0.00	0.05	82.09	16.90
10/5/2008	2450	WRU2	2	6.41	6.78	0.00	0.09	82.09	31.80
10/5/2008	2451	WRU3	3	5.13	5.47	0.00	0.08	65.67	24.07
10/5/2008	2452	RRF1	1	2.21	1.38	0.00	0.02	5.77	3.97
10/5/2008	2453	RRF2	2	2.21	1.79	0.00	0.01	5.77	3.30
10/5/2008	2454	RRF3	3	2.21	0.92	0.00	0.01	5.77	5.55
10/5/2008	2455	RRU1	1	2.21	1.15	0.00	0.02	5.77	4.92
10/5/2008	2456	RRU2	2	2.21	2.26	0.00	0.03	5.77	9.30
10/5/2008	2457	RRU3	3	2.21	1.31	0.00	0.01	5.77	2.37
10/5/2008	2458	Blank1F	1	2.21	1.56	0.00	0.02	5.77	3.19
10/5/2008	2459	Blank2F	2	1.77	0.61	0.00	0.01	4.62	2.14
10/5/2008	2460	Blank1U	1	2.21	1.31	0.00	0.03	5.77	9.04
10/13/2008	2466	DRF1	1	0.18	4.28	0.07	0.10	77.23	35.81
10/13/2008	2467	DRF2	2	0.18	6.06	0.07	0.14	77.23	38.09
10/13/2008	2468	DRF3	3	0.18	6.29	0.07	0.15	77.23	44.73
10/13/2008	2469	DRU1	1	0.18	4.94	0.07	0.10	77.23	38.58

10/13/2008	2470	DRU2	2	0.18	4.25	0.07	0.06	77.23	32.93
10/13/2008	2471	DRU3	3	0.18	7.44	0.07	0.11	77.23	45.76
10/13/2008	2472	BRF1	1	1.42	14.39	0.02	0.27	78.88	46.37
10/13/2008	2473	BRF2	2	1.42	6.93	0.02	0.18	78.88	49.77
10/13/2008	2474	BRF3	3	1.42	10.74	0.02	0.17	78.88	59.48
10/13/2008	2475	BRU1	1	1.42	17.14	0.02	0.19	78.88	47.25
10/13/2008	2476	BRU2	2	1.42	11.15	0.02	0.11	78.88	54.49
10/13/2008	2477	BRU3	3	1.42	15.13	0.02	0.17	78.88	65.85
10/13/2008	2478	WRF1	1	6.20	8.48	0.01	0.13	81.69	68.15
10/13/2008	2479	WRF2	2	6.20	18.27	0.01	0.30	81.69	58.08
10/13/2008	2480	WRF3	3	6.20	11.59	0.01	0.17	81.69	55.78
10/13/2008	2481	WRU1	1	6.20	7.65	0.01	0.07	81.69	48.12
10/13/2008	2482	WRU2	2	6.20	15.23	0.01	0.14	81.69	49.35
10/13/2008	2483	WRU3	3	6.20	15.59	0.01	0.22	81.69	75.07
10/13/2008	2484	RRF1	1	1.92	1.42	0.00	0.02	5.90	4.49
10/13/2008	2485	RRF2	2	1.92	0.97	0.00	0.01	5.90	9.28
10/13/2008	2486	RRF3	3	1.92	1.00	0.00	0.01	5.90	4.41
10/13/2008	2487	RRU1	1	1.92	2.41	0.00	0.04	5.90	18.40
10/13/2008	2488	RRU2	2	1.92	1.59	0.00	0.02	5.90	8.31
10/13/2008	2489	RRU3	3	1.92	0.87	0.00	0.01	5.90	9.14
10/13/2008	2490	Blank1F	1	1.92	1.90	0.00	0.02	5.90	6.08
10/13/2008	2491	Blank2F	2	1.92	1.61	0.00	0.03	5.90	5.46
10/13/2008	2492	Blank1U	1	1.92	1.55	0.00	0.02	5.90	5.92
10/19/2008	2542	DRF1	1	0.22	3.33	0.07	0.11	77.73	52.40
10/19/2008	2543	DRF2	2	0.22	7.02	0.07	0.20	77.73	61.64
10/19/2008	2544	DRF3	3	0.22	7.10	0.07	0.18	77.73	55.25
10/19/2008	2545	DRU1	1	0.22	7.27	0.07	0.19	77.73	54.79
10/19/2008	2546	DRU2	2	0.22	3.77	0.07	0.09	77.73	33.13
10/19/2008	2547	DRU3	3	0.22	6.51	0.07	0.10	77.73	59.31
10/19/2008	2548	BRF1	1	0.85	13.75	0.01	0.24	72.53	55.41
10/19/2008	2549	BRF2	2	0.85	6.77	0.01	0.23	72.53	49.10

10/19/2008	2550	BRF3	3	0.85	20.63	0.01	0.36	72.53	70.28
10/19/2008	2551	BRU1	1	0.85	9.55	0.01	0.10	72.53	33.89
10/19/2008	2552	BRU2	2	0.85	7.29	0.01	0.10	72.53	51.31
10/19/2008	2553	BRU3	3	0.85	17.48	0.01	0.15	72.53	48.87
10/19/2008	2554	WRF1	1	5.77	9.13	0.01	0.18	85.01	65.19
10/19/2008	2555	WRF2	2	5.77	7.08	0.01	0.15	85.01	43.49
10/19/2008	2556	WRF3	3	5.77	13.10	0.01	0.20	85.01	60.70
10/19/2008	2557	WRU1	1	5.77	10.07	0.01	0.11	85.01	52.06
10/19/2008	2558	WRU2	2	5.77	8.87	0.01	0.13	85.01	65.44
10/19/2008	2559	WRU3	3	5.77	13.22	0.01	0.21	85.01	60.37
10/19/2008	2560	RRF1	1	2.23	1.51	0.01	0.03	10.25	5.90
10/19/2008	2561	RRF2	2	2.23	1.56	0.01	0.01	10.25	6.05
10/19/2008	2562	RRF3	3	2.23	1.51	0.01	0.01	10.25	5.11
10/19/2008	2563	RRU1	1	2.23	1.74	0.01	0.02	10.25	6.16
10/19/2008	2564	RRU2	2	2.23	1.60	0.01	0.03	10.25	13.89
10/19/2008	2565	RRU3	3	2.23	1.00	0.01	0.02	10.25	10.37
10/19/2008	2566	Blank1F	1	2.23	1.20	0.01	0.03	10.25	9.72
10/19/2008	2567	Blank2F	2	2.23	1.35	0.01	0.04	10.25	13.77
10/19/2008	2568	Blank1U	1	2.23	1.53	0.01	0.04	10.25	6.33
10/26/2008	2627	DRF1	1	0.28	3.49	0.09	0.11	96.45	32.70
10/26/2008	2628	DRF2	2	0.28	3.21	0.09	0.13	96.45	33.97
10/26/2008	2629	DRF3	3	0.28	4.05	0.09	0.14	96.45	44.60
10/26/2008	2630	DRU1	1	0.28	4.80	0.09	0.17	96.45	47.81
10/26/2008	2631	DRU2	2	0.28	6.87	0.09	0.15	96.45	47.34
10/26/2008	2632	DRU3	3	0.28	3.30	0.09	0.09	96.45	25.24
10/26/2008	2633	BRF1	1	9.44	5.23	0.01	0.16	96.05	26.70
10/26/2008	2634	BRF2	2	9.44	4.09	0.01	0.13	96.05	31.69
10/26/2008	2635	BRF3	3	9.44	9.30	0.01	0.13	96.05	41.07
10/26/2008	2636	BRU1	1	9.44	7.67	0.01	0.13	96.05	26.91
10/26/2008	2637	BRU2	2	9.44	8.31	0.01	0.13	96.05	40.97
10/26/2008	2638	BRU3	3	9.44	6.79	0.01	0.10	96.05	28.43

10/26/2008	2639	WRF1	1	15.11	11.43	0.01	0.26	107.61	85.00
10/26/2008	2640	WRF2	2	15.11	3.88	0.01	0.13	107.61	42.65
10/26/2008	2641	WRF3	3	15.11	3.76	0.01	0.08	107.61	20.37
10/26/2008	2642	WRU1	1	15.11	4.43	0.01	0.06	107.61	18.09
10/26/2008	2643	WRU2	2	15.11	5.86	0.01	0.10	107.61	34.22
10/26/2008	2644	WRU3	3	15.11	8.66	0.01	0.16	107.61	43.46
10/26/2008	2645	RRF1	1	2.11	1.24	0.02	0.02	10.07	2.51
10/26/2008	2646	RRF2	2	2.11	0.99	0.02	0.02	10.07	8.04
10/26/2008	2647	RRF3	3	2.11	1.65	0.02	0.02	10.07	1.66
10/26/2008	2648	RRU1	1	2.11	0.98	0.02	0.02	10.07	2.31
10/26/2008	2649	RRU2	2	2.11	1.83	0.02	0.04	10.07	16.04
10/26/2008	2650	RRU3	3	2.11	1.61	0.02	0.02	10.07	3.97
10/26/2008	2651	Blank1F	1	2.11	1.19	0.02	0.02	10.07	2.13
10/26/2008	2652	Blank2F	2	2.11	1.49	0.02	0.04	10.07	3.82
10/26/2008	2653	Blank1U	1	2.11	1.61	0.02	0.03	10.07	2.48

Appendix D. Input and output chemistry of N species

Date	A&M ID	Sample ID	Rep	Input TDN μg g	Output TDN μg g	Input NH_4-N μg g	Output NH_4-N μg g	Input NO_3-N μg g	Output NO_3-N μg g	Input DON μg g	Output DON μg g
6/9/2008	876	DRF	1	0.09	0.77	0.01	0.01	0.08	0.46	0.00	0.30
6/9/2008	877	DRF	2	0.09	1.41	0.01	0.01	0.08	1.23	0.00	0.17
6/9/2008	878	DRF	3	0.09	0.46	0.01	0.02	0.08	0.25	0.00	0.19
6/9/2008	879	DRU	1	0.09	0.82	0.01	0.04	0.08	0.72	0.00	0.06
6/9/2008	880	DRU	2	0.09	0.90	0.01	0.02	0.08	0.90	0.00	0.00
6/9/2008	881	DRU	3	0.09	0.48	0.01	0.01	0.08	0.33	0.00	0.14
6/9/2008	882	BRF	1	0.14	0.82	0.16	0.02	0.06	0.56	0.00	0.24
6/9/2008	883	BRF	2	0.14	0.66	0.16	0.01	0.06	0.43	0.00	0.22
6/9/2008	884	BRF	3	0.14	1.05	0.16	0.01	0.06	1.01	0.00	0.03
6/9/2008	885	BRU	1	0.14	0.54	0.16	0.08	0.06	0.30	0.00	0.16
6/9/2008	886	BRU	2	0.14	0.73	0.16	0.04	0.06	0.44	0.00	0.25
6/9/2008	887	BRU	3	0.14	0.63	0.16	0.02	0.06	0.60	0.00	0.00
6/9/2008	888	WRF	1	3.00	0.79	0.20	0.02	0.06	0.90	2.74	0.00
6/9/2008	889	WRF	2	3.00	1.13	0.20	0.06	0.06	1.05	2.74	0.02
6/9/2008	890	WRF	3	3.00	0.75	0.20	0.01	0.06	0.55	2.74	0.18
6/9/2008	891	WRU	1	3.00	0.43	0.20	0.02	0.06	0.31	2.74	0.10
6/9/2008	892	WRU	2	3.00	0.34	0.20	0.10	0.06	0.24	2.74	0.00
6/9/2008	893	WRU	3	3.00	0.73	0.20	0.06	0.06	0.54	2.74	0.12
6/9/2008	894	RRF	1	0.41	0.71	0.04	0.04	0.19	0.63	0.17	0.04
6/9/2008	895	RRF	2	0.41	0.34	0.04	0.03	0.19	0.27	0.17	0.04
6/9/2008	896	RRF	3	0.41	0.14	0.04	0.09	0.19	0.18	0.17	0.00
6/9/2008	897	RRU	1	0.41	0.77	0.04	0.09	0.19	0.66	0.17	0.01
6/9/2008	898	RRU	2	0.41	0.44	0.04	0.10	0.19	0.32	0.17	0.02
6/9/2008	899	RRU	3	0.41	0.40	0.04	0.06	0.19	0.34	0.17	0.00
6/9/2008	900	BLANK F	1	0.41	0.47	0.04	0.01	0.19	0.40	0.17	0.06
6/9/2008	901	BLANK F	2	0.55	3.59	0.05	0.04	0.26	3.54	0.24	0.01

6/9/2008	902	BLANK U	1	0.55	0.70	0.05	0.05	0.26	0.99	0.24	0.00
6/16/2008	987	DRF	1	0.09	0.38	0.01	0.01	0.08	0.16	0.00	0.22
6/16/2008	988	DRF	2	0.09	0.22	0.01	0.01	0.08	0.12	0.00	0.09
6/16/2008	989	DRF	3	0.09	0.32	0.01	0.01	0.08	0.12	0.00	0.19
6/16/2008	990	DRU	1	0.09	0.41	0.01	0.01	0.08	0.32	0.00	0.08
6/16/2008	991	DRU	2	0.09	0.26	0.01	0.01	0.08	0.19	0.00	0.07
6/16/2008	992	DRU	3	0.09	0.16	0.01	0.01	0.08	0.10	0.00	0.05
6/16/2008	993	BRF	1	0.14	0.53	0.16	0.01	0.06	0.17	0.00	0.34
6/16/2008	994	BRF	2	0.14	0.63	0.16	0.01	0.06	0.25	0.00	0.38
6/16/2008	995	BRF	3	0.14	0.72	0.16	0.01	0.06	0.43	0.00	0.28
6/16/2008	996	BRU	1	0.14	0.84	0.16	0.01	0.06	0.54	0.00	0.30
6/16/2008	997	BRU	2	0.14	0.61	0.16	0.01	0.06	0.49	0.00	0.11
6/16/2008	998	BRU	3	0.14	0.47	0.16	0.01	0.06	0.33	0.00	0.13
6/16/2008	999	WRF	1	3.00	0.70	0.20	0.02	0.06	0.37	2.74	0.31
6/16/2008	1000	WRF	2	3.00	0.59	0.20	0.02	0.06	0.35	2.74	0.22
6/16/2008	1001	WRF	3	3.00	0.69	0.20	0.01	0.06	0.43	2.74	0.25
6/16/2008	1002	WRU	1	3.00	0.38	0.20	0.01	0.06	0.21	2.74	0.17
6/16/2008	1003	WRU	2	3.00	0.61	0.20	0.02	0.06	0.50	2.74	0.09
6/16/2008	1004	WRU	3	3.00	1.16	0.20	0.02	0.06	0.90	2.74	0.24
6/16/2008	1005	RRF	1	0.41	0.89	0.04	0.01	0.19	0.78	0.17	0.11
6/16/2008	1006	RRF	2	0.41	0.30	0.04	0.01	0.19	0.22	0.17	0.08
6/16/2008	1007	RRF	3	0.41	0.27	0.04	0.01	0.19	0.19	0.17	0.07
6/16/2008	1008	RRU	1	0.41	0.72	0.04	0.01	0.19	0.51	0.17	0.21
6/16/2008	1009	RRU	2	0.41	0.34	0.04	0.01	0.19	0.20	0.17	0.14
6/16/2008	1010	RRU	3	0.41	0.35	0.04	0.01	0.19	0.22	0.17	0.12
6/16/2008	1011	BLANK F	1	0.41	0.18	0.04	0.01	0.19	0.10	0.17	0.07
6/16/2008	1012	BLANK F	2	0.41	0.34	0.04	0.01	0.19	0.26	0.17	0.07
6/16/2008	1013	BLANK U	1	0.41	0.53	0.04	0.00	0.19	0.48	0.17	0.04
6/23/2008	1045	DRF	1	0.09	0.45	0.01	0.00	0.08	0.15	0.00	0.30
6/23/2008	1046	DRF	2	0.09	0.47	0.01	0.00	0.08	0.18	0.00	0.29
6/23/2008	1047	DRF	3	0.09	0.39	0.01	0.00	0.08	0.12	0.00	0.27

6/23/2008	1048	DRU	1	0.09	0.44	0.01	0.00	0.08	0.16	0.00	0.27
6/23/2008	1049	DRU	2	0.09	0.53	0.01	0.00	0.08	0.26	0.00	0.27
6/23/2008	1050	DRU	3	0.09	0.44	0.01	0.00	0.08	0.16	0.00	0.28
6/23/2008	1051	BRF	1	0.14	0.57	0.16	0.01	0.06	0.25	0.00	0.32
6/23/2008	1052	BRF	2	0.14	0.47	0.16	0.01	0.06	0.22	0.00	0.25
6/23/2008	1053	BRF	3	0.14	0.41	0.16	0.01	0.06	0.17	0.00	0.23
6/23/2008	1054	BRU	1	0.14	0.31	0.16	0.01	0.06	0.09	0.00	0.21
6/23/2008	1055	BRU	2	0.14	0.33	0.16	0.01	0.06	0.05	0.00	0.27
6/23/2008	1056	BRU	3	0.14	0.37	0.16	0.01	0.06	0.23	0.00	0.13
6/23/2008	1057	WRF	1	3.00	0.33	0.20	0.01	0.06	0.11	2.74	0.21
6/23/2008	1058	WRF	2	3.00	0.43	0.20	0.01	0.06	0.22	2.74	0.20
6/23/2008	1059	WRF	3	3.00	0.29	0.20	0.01	0.06	0.12	2.74	0.16
6/23/2008	1060	WRU	1	3.00	0.39	0.20	0.01	0.06	0.16	2.74	0.23
6/23/2008	1061	WRU	2	3.00	0.20	0.20	0.01	0.06	0.09	2.74	0.10
6/23/2008	1062	WRU	3	3.00	0.25	0.20	0.01	0.06	0.11	2.74	0.13
6/23/2008	1063	RRF	1	0.41	0.22	0.04	0.00	0.19	0.08	0.17	0.14
6/23/2008	1064	RRF	2	0.41	0.06	0.04	0.00	0.19	0.15	0.17	0.00
6/23/2008	1065	RRF	3	0.41	0.30	0.04	0.00	0.19	0.14	0.17	0.16
6/23/2008	1066	RRU	1	0.41	0.25	0.04	0.00	0.19	0.10	0.17	0.15
6/23/2008	1067	RRU	2	0.41	0.23	0.04	0.00	0.19	0.11	0.17	0.12
6/23/2008	1068	RRU	3	0.41	0.36	0.04	0.00	0.19	0.19	0.17	0.17
6/23/2008	1069	BLANK F	1	0.41	0.39	0.04	0.00	0.19	0.23	0.17	0.16
6/23/2008	1070	BLANK F	2	0.41	0.29	0.04	0.00	0.19	0.12	0.17	0.16
6/23/2008	1071	BLANK U	1	0.41	0.29	0.04	0.00	0.19	0.15	0.17	0.14
6/30/2008	1073	DRF	1	0.09	0.25	0.01	0.01	0.08	0.06	0.00	0.19
6/30/2008	1074	DRF	2	0.09	0.29	0.01	0.01	0.08	0.04	0.00	0.25
6/30/2008	1075	DRF	3	0.09	0.27	0.01	0.01	0.08	0.05	0.00	0.22
6/30/2008	1076	DRU	1	0.09	0.41	0.01	0.01	0.08	0.11	0.00	0.29
6/30/2008	1077	DRU	2	0.09	0.50	0.01	0.01	0.08	0.17	0.00	0.32
6/30/2008	1078	DRU	3	0.09	0.15	0.01	0.01	0.08	0.01	0.00	0.14
6/30/2008	1079	BRF	1	0.14	0.19	0.16	0.01	0.06	0.06	0.00	0.13

6/30/2008	1080	BRF	2	0.14	0.19	0.16	0.01	0.06	0.07	0.00	0.11
6/30/2008	1081	BRF	3	0.14	0.87	0.16	0.01	0.06	0.05	0.00	0.81
6/30/2008	1082	BRU	1	0.14	0.34	0.16	0.01	0.06	0.29	0.00	0.04
6/30/2008	1083	BRU	2	0.14	0.45	0.16	0.01	0.06	0.10	0.00	0.34
6/30/2008	1084	BRU	3	0.14	0.31	0.16	0.01	0.06	0.30	0.00	0.00
6/30/2008	1085	WRF	1	3.00	0.75	0.20	0.01	0.06	0.10	2.74	0.64
6/30/2008	1086	WRF	2	3.00	0.52	0.20	0.01	0.06	0.26	2.74	0.25
6/30/2008	1087	WRF	3	3.00	0.41	0.20	0.01	0.06	0.18	2.74	0.22
6/30/2008	1088	WRU	1	3.00	0.54	0.20	0.01	0.06	0.13	2.74	0.41
6/30/2008	1089	WRU	2	3.00	0.57	0.20	0.01	0.06	0.24	2.74	0.32
6/30/2008	1090	WRU	3	3.00	0.25	0.20	0.01	0.06	0.33	2.74	0.00
6/30/2008	1091	RRF	1	0.41	0.28	0.04	0.00	0.19	0.07	0.17	0.22
6/30/2008	1092	RRF	2	0.41	0.22	0.04	0.00	0.19	0.09	0.17	0.12
6/30/2008	1093	RRF	3	0.41	0.24	0.04	0.00	0.19	0.04	0.17	0.20
6/30/2008	1094	RRU	1	0.41	0.22	0.04	0.00	0.19	0.11	0.17	0.10
6/30/2008	1095	RRU	2	0.41	0.32	0.04	0.00	0.19	0.09	0.17	0.23
6/30/2008	1096	RRU	3	0.41	0.32	0.04	0.00	0.19	0.11	0.17	0.20
6/30/2008	1097	BLANK F	1	0.41	0.14	0.04	0.00	0.19	0.17	0.17	0.00
6/30/2008	1098	BLANK F	2	0.41	0.42	0.04	0.00	0.19	0.08	0.17	0.34
6/30/2008	1099	BLANK U	1	0.41	0.41	0.04	0.00	0.19	0.20	0.17	0.21
7/7/2008	1119	DRF	1	0.46	0.43	0.01	0.01	0.08	0.06	0.37	0.36
7/7/2008	1120	DRF	2	0.46	0.29	0.01	0.01	0.08	0.03	0.37	0.25
7/7/2008	1121	DRF	3	0.46	0.27	0.01	0.01	0.08	0.04	0.37	0.22
7/7/2008	1122	DRU	1	0.46	0.35	0.01	0.01	0.08	0.08	0.37	0.26
7/7/2008	1123	DRU	2	0.46	0.56	0.01	0.02	0.08	0.09	0.37	0.46
7/7/2008	1124	DRU	3	0.46	0.29	0.01	0.01	0.08	0.06	0.37	0.22
7/7/2008	1125	BRF	1	1.29	0.93	0.06	0.01	0.06	0.36	1.17	0.55
7/7/2008	1126	BRF	2	1.29	0.26	0.06	0.01	0.06	0.11	1.17	0.13
7/7/2008	1127	BRF	3	1.29	0.37	0.06	0.01	0.06	0.11	1.17	0.24
7/7/2008	1128	BRU	1	1.29	0.48	0.06	0.01	0.06	0.15	1.17	0.32
7/7/2008	1129	BRU	2	1.29	0.56	0.06	0.01	0.06	0.15	1.17	0.40

7/7/2008	1130	BRU	3	1.29	0.47	0.06	0.01	0.06	0.27	1.17	0.20
7/7/2008	1131	WRF	1	2.91	0.36	0.19	0.01	0.05	0.09	2.66	0.26
7/7/2008	1132	WRF	2	2.91	0.54	0.19	0.01	0.05	0.13	2.66	0.39
7/7/2008	1133	WRF	3	2.91	0.38	0.19	0.01	0.05	0.07	2.66	0.30
7/7/2008	1134	WRU	1	2.91	0.45	0.19	0.01	0.05	0.08	2.66	0.36
7/7/2008	1135	WRU	2	2.91	0.45	0.19	0.01	0.05	0.13	2.66	0.31
7/7/2008	1136	WRU	3	2.91	0.52	0.19	0.01	0.05	0.19	2.66	0.32
7/7/2008	1137	RRF	1	0.09	0.28	0.01	0.01	0.32	0.07	0.00	0.21
7/7/2008	1138	RRF	2	0.09	0.28	0.01	0.01	0.32	0.07	0.00	0.20
7/7/2008	1139	RRF	3	0.09	0.23	0.01	0.01	0.32	0.04	0.00	0.18
7/7/2008	1140	RRU	1	0.09	0.30	0.01	0.01	0.32	0.08	0.00	0.21
7/7/2008	1141	RRU	2	0.09	0.30	0.01	0.01	0.32	0.08	0.00	0.21
7/7/2008	1142	RRU	3	0.09	0.22	0.01	0.01	0.32	0.08	0.00	0.13
7/7/2008	1143	BLANK F	1	0.09	0.27	0.01	0.01	0.32	0.17	0.00	0.10
7/7/2008	1144	BLANK F	2	0.09	0.23	0.01	0.01	0.32	0.12	0.00	0.09
7/7/2008	1145	BLANK U	1	0.09	0.20	0.01	0.01	0.32	0.12	0.00	0.08
7/14/2008	1248	DRF	1	0.09	0.00	0.02	0.01	0.05	0.03	0.02	0.00
7/14/2008	1249	DRF	2	0.09	0.22	0.02	0.01	0.05	0.02	0.02	0.19
7/14/2008	1250	DRF	3	0.09	0.30	0.02	0.01	0.05	0.03	0.02	0.26
7/14/2008	1251	DRU	1	0.09	0.26	0.02	0.01	0.05	0.03	0.02	0.22
7/14/2008	1252	DRU	2	0.09	0.37	0.02	0.01	0.05	0.04	0.02	0.31
7/14/2008	1253	DRU	3	0.09	0.12	0.02	0.01	0.05	0.03	0.02	0.08
7/14/2008	1254	BRF	1	1.62	0.68	0.52	0.01	0.04	0.22	1.06	0.45
7/14/2008	1255	BRF	2	1.62	0.39	0.52	0.01	0.04	0.13	1.06	0.25
7/14/2008	1256	BRF	3	1.62	0.45	0.52	0.01	0.04	0.11	1.06	0.34
7/14/2008	1257	BRU	1	1.62	0.63	0.52	0.01	0.04	0.12	1.06	0.49
7/14/2008	1258	BRU	2	1.62	0.47	0.52	0.01	0.04	0.09	1.06	0.37
7/14/2008	1259	BRU	3	1.62	0.32	0.52	0.01	0.04	0.14	1.06	0.17
7/14/2008	1260	WRF	1	3.26	0.34	0.86	0.01	0.02	0.04	2.38	0.29
7/14/2008	1261	WRF	2	3.26	0.60	0.86	0.01	0.02	0.08	2.38	0.51
7/14/2008	1262	WRF	3	3.26	0.71	0.86	0.01	0.02	0.09	2.38	0.61

7/14/2008	1263	WRU	1	3.26	0.58	0.86	0.01	0.02	0.06	2.38	0.50
7/14/2008	1264	WRU	2	3.26	0.58	0.86	0.01	0.02	0.12	2.38	0.45
7/14/2008	1265	WRU	3	3.26	0.51	0.86	0.02	0.02	0.18	2.38	0.32
7/14/2008	1266	RRF	1	0.25	0.17	0.01	0.01	0.22	0.04	0.03	0.12
7/14/2008	1267	RRF	2	0.25	0.16	0.01	0.01	0.22	0.04	0.03	0.12
7/14/2008	1268	RRF	3	0.25	0.16	0.01	0.01	0.22	0.02	0.03	0.13
7/14/2008	1269	RRU	1	0.25	0.20	0.01	0.01	0.22	0.04	0.03	0.15
7/14/2008	1270	RRU	2	0.25	0.20	0.01	0.01	0.22	0.04	0.03	0.16
7/14/2008	1271	RRU	3	0.25	0.13	0.01	0.01	0.22	0.04	0.03	0.08
7/14/2008	1272	BLANK F	1	0.25	0.11	0.01	0.01	0.22	0.15	0.03	0.00
7/14/2008	1273	BLANK F	2	0.25	0.26	0.01	0.01	0.22	0.10	0.03	0.15
7/14/2008	1274	BLANK U	1	0.25	0.26	0.01	0.01	0.22	0.17	0.03	0.07
7/21/2008	1335	DRF	1	0.08	0.21	0.01	0.01	0.05	0.03	0.02	0.17
7/21/2008	1336	DRF	2	0.08	0.26	0.01	0.00	0.05	0.03	0.02	0.23
7/21/2008	1337	DRF	3	0.08	0.27	0.01	0.01	0.05	0.03	0.02	0.23
7/21/2008	1332	DRU	1	0.08	0.30	0.01	0.01	0.05	0.04	0.02	0.26
7/21/2008	1333	DRU	2	0.08	0.18	0.01	0.00	0.05	0.03	0.02	0.15
7/21/2008	1334	DRU	3	0.08	0.09	0.01	0.00	0.05	0.02	0.02	0.06
7/21/2008	1329	BRF	1	1.64	0.34	0.54	0.01	0.03	0.10	1.07	0.23
7/21/2008	1330	BRF	2	1.64	0.21	0.54	0.00	0.03	0.06	1.07	0.15
7/21/2008	1331	BRF	3	1.64	0.26	0.54	0.01	0.03	0.05	1.07	0.21
7/21/2008	1326	BRU	1	1.64	0.36	0.54	0.00	0.03	0.07	1.07	0.29
7/21/2008	1327	BRU	2	1.64	0.33	0.54	0.00	0.03	0.04	1.07	0.28
7/21/2008	1328	BRU	3	1.64	0.19	0.54	0.00	0.03	0.07	1.07	0.11
7/21/2008	1325	WRF	2	3.43	0.47	1.00	0.01	0.02	0.09	2.41	0.37
7/21/2008	1345	WRF	3	3.43	0.42	1.00	0.01	0.02	0.11	2.41	0.31
7/21/2008	1346	WRF	1	3.43	0.23	1.00	0.01	0.02	0.04	2.41	0.18
7/21/2008	1342	WRU	1	3.43	0.24	1.00	0.01	0.02	0.07	2.41	0.17
7/21/2008	1343	WRU	2	3.43	0.35	1.00	0.01	0.02	0.10	2.41	0.25
7/21/2008	1344	WRU	3	3.43	0.36	1.00	0.01	0.02	0.09	2.41	0.25
7/21/2008	1347	RRF	2	0.15	0.10	0.01	0.00	0.10	0.02	0.05	0.07

7/21/2008	1348	RRF	1	0.15	0.12	0.01	0.00	0.10	0.02	0.05	0.10
7/21/2008	1349	RRF	3	0.15	0.11	0.01	0.00	0.10	0.02	0.05	0.09
7/21/2008	1324	RRU	1	0.15	0.00	0.01	0.00	0.10	0.00	0.05	0.00
7/21/2008	1341	RRU	2	0.15	0.12	0.01	0.00	0.10	0.02	0.05	0.09
7/21/2008	1350	RRU	3	0.15	0.08	0.01	0.00	0.10	0.02	0.05	0.05
7/21/2008	1338	BLANK F	1	0.15	0.12	0.01	0.00	0.05	0.07	0.10	0.05
7/21/2008	1339	BLANK F	2	0.15	0.10	0.01	0.00	0.10	0.05	0.05	0.05
7/21/2008	1340	BLANK U	1	0.15	0.16	0.01	0.00	0.10	0.09	0.05	0.07
7/29/2008	1358	DRF	1	0.08	0.14	0.01	0.00	0.06	0.02	0.01	0.12
7/29/2008	1359	DRF	2	0.08	0.19	0.01	0.01	0.06	0.03	0.01	0.16
7/29/2008	1360	DRF	3	0.08	0.19	0.01	0.01	0.06	0.03	0.01	0.15
7/29/2008	1361	DRU	1	0.08	0.16	0.01	0.00	0.06	0.03	0.01	0.14
7/29/2008	1362	DRU	2	0.08	0.17	0.01	0.01	0.06	0.02	0.01	0.15
7/29/2008	1363	DRU	3	0.08	0.08	0.01	0.00	0.06	0.02	0.01	0.05
7/29/2008	1364	BRF	1	4.81	0.47	2.54	0.02	0.02	0.12	2.25	0.32
7/29/2008	1365	BRF	2	4.81	0.58	2.54	0.08	0.02	0.11	2.25	0.40
7/29/2008	1366	BRF	3	4.81	0.36	2.54	0.03	0.02	0.05	2.25	0.28
7/29/2008	1367	BRU	1	4.81	0.83	2.54	0.07	0.02	0.12	2.25	0.64
7/29/2008	1368	BRU	2	4.81	0.48	2.54	0.03	0.02	0.05	2.25	0.40
7/29/2008	1369	BRU	3	4.81	0.65	2.54	0.07	0.02	0.11	2.25	0.47
7/29/2008	1370	WRF	1	2.16	0.24	0.06	0.01	0.03	0.04	2.08	0.20
7/29/2008	1371	WRF	2	2.16	0.43	0.06	0.01	0.03	0.07	2.08	0.36
7/29/2008	1372	WRF	3	2.16	0.32	0.06	0.01	0.03	0.03	2.08	0.27
7/29/2008	1373	WRU	1	2.16	0.22	0.06	0.01	0.03	0.04	2.08	0.17
7/29/2008	1374	WRU	2	2.16	0.30	0.06	0.01	0.03	0.07	2.08	0.22
7/29/2008	1375	WRU	3	2.16	0.20	0.06	0.01	0.03	0.03	2.08	0.15
7/29/2008	1376	RRF	1	0.99	0.10	0.05	0.00	0.06	0.03	0.88	0.07
7/29/2008	1377	RRF	2	0.99	0.07	0.05	0.00	0.06	0.03	0.88	0.03
7/29/2008	1378	RRF	3	0.99	0.08	0.05	0.00	0.06	0.02	0.88	0.06
7/29/2008	1379	RRU	1	0.99	0.11	0.05	0.00	0.06	0.03	0.88	0.08
7/29/2008	1380	RRU	2	0.99	0.14	0.05	0.01	0.06	0.03	0.88	0.10

7/29/2008	1381	RRU	3	0.99	0.08	0.05	0.01	0.06	0.02	0.88	0.05
7/29/2008	1382	BLANK F	1	0.99	0.10	0.05	0.00	0.06	0.06	0.88	0.04
7/29/2008	1383	BLANK F	2	0.99	0.11	0.05	0.00	0.06	0.05	0.88	0.05
7/29/2008	1384	BLANK U	1	0.99	0.10	0.05	0.00	0.06	0.06	0.88	0.03
8/4/2008	1420	DRF1	1	0.15	0.49	0.04	0.01	0.06	0.07	0.05	0.41
8/4/2008	1421	DRF2	2	0.15	0.28	0.04	0.01	0.06	0.06	0.05	0.21
8/4/2008	1422	DRF3	3	0.15	0.34	0.04	0.01	0.06	0.06	0.05	0.27
8/4/2008	1423	DRU1	1	0.15	0.38	0.04	0.01	0.06	0.05	0.05	0.32
8/4/2008	1424	DRU2	2	0.15	0.47	0.04	0.01	0.06	0.05	0.05	0.40
8/4/2008	1425	DRU3	3	0.15	0.19	0.04	0.01	0.06	0.04	0.05	0.14
8/4/2008	1426	BRF1	1	28.95	2.71	11.86	0.18	0.02	1.99	17.06	0.54
8/4/2008	1427	BRF2	2	28.95	2.31	11.86	0.26	0.02	1.55	17.06	0.51
8/4/2008	1428	BRF3	3	28.95	2.09	11.86	0.26	0.02	0.85	17.06	0.98
8/4/2008	1429	BRU1	1	28.95	2.33	11.86	0.29	0.02	1.30	17.06	0.75
8/4/2008	1430	BRU2	2	28.95	2.46	11.86	0.25	0.02	1.15	17.06	1.06
8/4/2008	1431	BRU3	3	28.95	2.93	11.86	0.15	0.02	2.26	17.06	0.52
8/4/2008	1432	WRF1	1	3.14	0.68	0.39	0.02	0.03	0.09	2.72	0.57
8/4/2008	1433	WRF2	2	3.14	0.69	0.39	0.01	0.03	0.09	2.72	0.58
8/4/2008	1434	WRF3	3	3.14	0.85	0.39	0.02	0.03	0.10	2.72	0.73
8/4/2008	1435	WRU1	1	3.14	0.80	0.39	0.02	0.03	0.07	2.72	0.71
8/4/2008	1436	WRU2	2	3.14	0.52	0.39	0.02	0.03	0.08	2.72	0.42
8/4/2008	1437	WRU3	3	3.14	0.62	0.39	0.01	0.03	0.05	2.72	0.56
8/4/2008	1438	RRF1	1	0.60	0.28	0.01	0.01	0.34	0.09	0.25	0.18
8/4/2008	1439	RRF2	2	0.60	0.22	0.01	0.01	0.34	0.08	0.25	0.13
8/4/2008	1440	RRF3	3	0.60	0.28	0.01	0.01	0.34	0.05	0.25	0.22
8/4/2008	1441	RRU1	1	0.60	0.16	0.01	0.01	0.34	0.08	0.25	0.08
8/4/2008	1442	RRU2	2	0.60	0.31	0.01	0.01	0.34	0.08	0.25	0.22
8/4/2008	1443	RRU3	3	0.60	0.20	0.01	0.01	0.34	0.08	0.25	0.12
8/4/2008	1444	B1F	1	0.60	0.40	0.01	0.01	0.34	0.21	0.25	0.18
8/4/2008	1445	B2F	2	0.60	0.32	0.01	0.01	0.34	0.17	0.25	0.14
8/4/2008	1446	B1U	1	0.60	0.27	0.01	0.01	0.34	0.17	0.25	0.09

8/11/2008	1608	DRF1	1	0.08	0.58	0.02	0.01	0.07	0.11	0.00	0.46
8/11/2008	1609	DRF2	2	0.08	0.28	0.02	0.01	0.07	0.07	0.00	0.20
8/11/2008	1610	DRF3	3	0.08	0.36	0.02	0.01	0.07	0.06	0.00	0.29
8/11/2008	1611	DRU1	1	0.08	0.61	0.02	0.01	0.07	0.11	0.00	0.49
8/11/2008	1612	DRU2	2	0.08	0.28	0.02	0.01	0.07	0.04	0.00	0.23
8/11/2008	1613	DRU3	3	0.08	0.28	0.02	0.01	0.07	0.07	0.00	0.20
8/11/2008	1614	BRF1	1	28.46	1.94	13.31	0.03	0.02	1.48	15.13	0.43
8/11/2008	1615	BRF2	2	28.46	4.65	13.31	0.30	0.02	3.96	15.13	0.38
8/11/2008	1616	BRF3	3	28.46	3.51	13.31	0.08	0.02	2.93	15.13	0.50
8/11/2008	1617	BRU1	1	28.46	4.29	13.31	0.09	0.02	3.46	15.13	0.73
8/11/2008	1618	BRU2	2	28.46	3.55	13.31	0.10	0.02	2.96	15.13	0.49
8/11/2008	1619	BRU3	3	28.46	4.38	13.31	0.08	0.02	3.90	15.13	0.41
8/11/2008	1620	WRF1	1	3.10	0.84	0.36	0.02	0.03	0.11	2.71	0.71
8/11/2008	1621	WRF2	2	3.10	0.39	0.36	0.01	0.03	0.07	2.71	0.30
8/11/2008	1622	WRF3	3	3.10	0.70	0.36	0.02	0.03	0.11	2.71	0.57
8/11/2008	1623	WRU1	1	3.10	0.82	0.36	0.02	0.03	0.10	2.71	0.70
8/11/2008	1624	WRU2	2	3.10	0.76	0.36	0.02	0.03	0.12	2.71	0.62
8/11/2008	1625	WRU3	3	3.10	0.74	0.36	0.02	0.03	0.10	2.71	0.62
8/11/2008	1626	RRF1	1	0.39	0.20	0.01	0.01	0.20	0.09	0.18	0.10
8/11/2008	1627	RRF2	2	0.39	0.14	0.01	0.01	0.20	0.04	0.18	0.09
8/11/2008	1628	RRF3	3	0.39	0.22	0.01	0.01	0.20	0.05	0.18	0.16
8/11/2008	1629	RRU1	1	0.39	0.30	0.01	0.01	0.20	0.11	0.18	0.19
8/11/2008	1630	RRU2	2	0.39	0.55	0.01	0.01	0.20	0.16	0.18	0.38
8/11/2008	1631	RRU3	3	0.39	0.21	0.01	0.01	0.20	0.06	0.18	0.14
8/11/2008	1632	Blank1F	1	0.39	0.36	0.01	0.00	0.20	0.17	0.18	0.19
8/11/2008	1633	Blank2F	2	0.39	0.45	0.01	0.01	0.20	0.24	0.18	0.20
8/11/2008	1634	Blank1U	1	0.39	0.36	0.01	0.01	0.20	0.21	0.18	0.15
8/18/2008	1640	DRF1	1	0.02	0.43	0.01	0.01	0.02	0.10	0.00	0.32
8/18/2008	1641	DRF2	2	0.02	0.37	0.01	0.01	0.02	0.05	0.00	0.31
8/18/2008	1642	DRF3	3	0.02	0.60	0.01	0.01	0.02	0.10	0.00	0.49
8/18/2008	1643	DRU1	1	0.02	0.40	0.01	0.01	0.02	0.11	0.00	0.28

8/18/2008	1644	DRU2	2	0.02	0.55	0.01	0.01	0.02	0.09	0.00	0.45
8/18/2008	1645	DRU3	3	0.02	0.23	0.01	0.01	0.02	0.08	0.00	0.14
8/18/2008	1646	BRF1	1	13.12	3.82	4.74	0.02	0.02	3.33	8.36	0.46
8/18/2008	1647	BRF2	2	13.12	3.50	4.74	0.03	0.02	3.47	8.36	0.00
8/18/2008	1648	BRF3	3	13.12	3.92	4.74	0.10	0.02	2.81	8.36	1.00
8/18/2008	1649	BRU1	1	13.12	3.47	4.74	0.08	0.02	2.66	8.36	0.73
8/18/2008	1650	BRU2	2	13.12	2.56	4.74	0.05	0.02	2.53	8.36	-0.01
8/18/2008	1651	BRU3	3	13.12	4.94	4.74	0.05	0.02	4.31	8.36	0.58
8/18/2008	1652	WRF1	1	1.83	0.85	0.31	0.03	0.12	0.12	1.41	0.70
8/18/2008	1653	WRF2	2	1.83	1.35	0.31	0.03	0.12	0.08	1.41	1.23
8/18/2008	1654	WRF3	3	1.83	1.10	0.31	0.05	0.12	0.08	1.41	0.97
8/18/2008	1655	WRU1	1	1.83	0.87	0.31	0.02	0.12	0.14	1.41	0.72
8/18/2008	1656	WRU2	2	1.83	0.99	0.31	0.03	0.12	0.12	1.41	0.84
8/18/2008	1657	WRU3	3	1.83	1.06	0.31	0.02	0.12	0.15	1.41	0.89
8/18/2008	1658	RRF1	1	0.49	0.35	0.09	0.01	0.26	0.19	0.13	0.15
8/18/2008	1659	RRF2	2	0.49	0.23	0.09	0.01	0.26	0.13	0.13	0.09
8/18/2008	1660	RRF3	3	0.49	0.20	0.09	0.01	0.26	0.10	0.13	0.10
8/18/2008	1661	RRU1	1	0.49	0.35	0.09	0.01	0.26	0.21	0.13	0.14
8/18/2008	1662	RRU2	2	0.49	0.31	0.09	0.00	0.26	0.11	0.13	0.19
8/18/2008	1663	RRU3	3	0.49	0.12	0.09	0.01	0.26	0.07	0.13	0.04
8/18/2008	1664	B1F	1	0.49	0.31	0.09	0.00	0.26	0.16	0.13	0.14
8/18/2008	1665	B2F	2	0.49	0.27	0.09	0.01	0.26	0.16	0.13	0.10
8/18/2008	1666	B1U	1	0.49	0.42	0.09	0.01	0.26	0.22	0.13	0.19
8/25/2008	1732	DRF1	1	0.06	0.35	0.00	0.01	0.10	0.11	0.00	0.23
8/25/2008	1733	DRF2	2	0.06	0.85	0.00	0.01	0.10	0.15	0.00	0.69
8/25/2008	1734	DRF3	3	0.06	0.34	0.00	0.01	0.10	0.03	0.00	0.31
8/25/2008	1735	DRU1	1	0.06	0.41	0.00	0.01	0.10	0.14	0.00	0.27
8/25/2008	1736	DRU2	2	0.06	0.31	0.00	0.01	0.10	0.10	0.00	0.20
8/25/2008	1737	DRU3	3	0.06	0.20	0.00	0.00	0.10	0.11	0.00	0.08
8/25/2008	1738	BRF1	1	0.55	2.83	0.09	0.01	0.12	2.22	0.34	0.61
8/25/2008	1739	BRF2	2	0.55	3.72	0.09	0.02	0.12	3.69	0.34	0.00

8/25/2008	1740	BRF3	3	0.55	2.90	0.09	0.01	0.12	3.00	0.34	0.00
8/25/2008	1741	BRU1	1	0.55	2.73	0.09	0.02	0.12	1.95	0.34	0.76
8/25/2008	1742	BRU2	2	0.55	1.60	0.09	0.01	0.12	1.35	0.34	0.24
8/25/2008	1743	BRU3	3	0.55	3.17	0.09	0.01	0.12	2.92	0.34	0.25
8/25/2008	1744	WRF1	1	1.17	0.52	0.06	0.01	0.07	0.29	1.04	0.22
8/25/2008	1745	WRF2	2	1.17	0.60	0.06	0.01	0.07	0.18	1.04	0.41
8/25/2008	1746	WRF3	3	1.17	0.91	0.06	0.02	0.07	0.39	1.04	0.50
8/25/2008	1747	WRU1	1	1.17	0.57	0.06	0.01	0.07	0.22	1.04	0.35
8/25/2008	1748	WRU2	2	1.17	0.52	0.06	0.01	0.07	0.17	1.04	0.34
8/25/2008	1749	WRU3	3	1.17	0.33	0.06	0.01	0.07	0.02	1.04	0.31
8/25/2008	1750	RRF1	1	0.27	0.18	0.00	0.00	0.25	0.15	0.01	0.02
8/25/2008	1751	RRF2	2	0.27	0.11	0.00	0.00	0.25	0.11	0.01	0.00
8/25/2008	1752	RRF3	3	0.27	0.13	0.00	0.00	0.25	0.11	0.01	0.01
8/25/2008	1753	RRU1	1	0.27	0.17	0.00	0.00	0.25	0.13	0.01	0.04
8/25/2008	1754	RRU2	2	0.27	0.15	0.00	0.00	0.25	0.11	0.01	0.04
8/25/2008	1755	RRU3	3	0.27	0.11	0.00	0.00	0.25	0.10	0.01	0.01
8/25/2008	1756	Blank1F	1	0.27	0.19	0.00	0.00	0.25	0.23	0.01	0.00
8/25/2008	1757	Blank2F	2	0.27	0.23	0.00	0.00	0.25	0.18	0.01	0.05
8/25/2008	1758	Blank1U	1	0.27	0.17	0.00	0.00	0.25	0.18	0.01	-0.01
9/1/2008	1830	DRF1	1	0.01	0.24	0.00	0.01	0.02	0.06	-0.01	0.17
9/1/2008	1831	DRF2	2	0.01	0.26	0.00	0.01	0.02	0.07	-0.01	0.19
9/1/2008	1832	DRF3	3	0.01	0.19	0.00	0.00	0.02	0.06	-0.01	0.13
9/1/2008	1833	DRU1	1	0.01	0.22	0.00	0.00	0.02	0.08	-0.01	0.13
9/1/2008	1834	DRU2	2	0.01	0.59	0.00	0.01	0.02	0.14	-0.01	0.44
9/1/2008	1835	DRU3	3	0.01	0.20	0.00	0.00	0.02	0.06	-0.01	0.14
9/1/2008	1836	BRF1	1	0.69	3.11	0.19	0.01	0.03	2.29	0.47	0.81
9/1/2008	1837	BRF2	2	0.69	3.47	0.19	0.01	0.03	2.92	0.47	0.54
9/1/2008	1838	BRF3	3	0.69	1.85	0.19	0.01	0.03	0.82	0.47	1.01
9/1/2008	1839	BRU1	1	0.69	1.48	0.19	0.01	0.03	0.69	0.47	0.78
9/1/2008	1840	BRU2	2	0.69	0.75	0.19	0.01	0.03	0.30	0.47	0.45
9/1/2008	1841	BRU3	3	0.69	2.74	0.19	0.01	0.03	2.19	0.47	0.54

9/1/2008	1842	WRF1	1	1.48	0.53	0.20	0.01	0.02	0.11	1.26	0.42
9/1/2008	1843	WRF2	2	1.48	0.35	0.20	0.01	0.02	0.09	1.26	0.25
9/1/2008	1844	WRF3	3	1.48	0.79	0.20	0.02	0.02	0.14	1.26	0.64
9/1/2008	1845	WRU1	1	1.48	0.55	0.20	0.01	0.02	0.07	1.26	0.46
9/1/2008	1846	WRU2	2	1.48	0.49	0.20	0.01	0.02	0.10	1.26	0.38
9/1/2008	1847	WRU3	3	1.48	0.75	0.20	0.01	0.02	0.13	1.26	0.61
9/1/2008	1848	RRF1	1	0.13	0.27	0.00	0.01	0.07	0.11	0.05	0.15
9/1/2008	1849	RRF2	2	0.13	0.27	0.00	0.01	0.07	0.07	0.05	0.19
9/1/2008	1850	RRF3	3	0.13	0.28	0.00	0.01	0.07	0.10	0.05	0.17
9/1/2008	1851	RRU1	1	0.13	0.21	0.00	0.00	0.07	0.12	0.05	0.08
9/1/2008	1852	RRU2	2	0.13	0.15	0.00	0.01	0.07	0.07	0.05	0.08
9/1/2008	1853	RRU3	3	0.13	0.31	0.00	0.01	0.07	0.07	0.05	0.24
9/1/2008	1854	Blank1F	1	0.13	0.17	0.00	0.00	0.07	0.12	0.05	0.04
9/1/2008	1855	Blank2F	2	0.13	0.12	0.00	0.01	0.07	0.20	0.05	-0.08
9/1/2008	1856	Blank1U	1	0.13	0.10	0.00	0.00	0.07	0.06	0.05	0.04
9/8/2008	1961	DRF1	2	0.10	0.33	0.00	0.01	0.06	0.04	0.04	0.28
9/8/2008	1962	DRF2	3	0.10	0.39	0.00	0.01	0.06	0.09	0.04	0.30
9/8/2008	1963	DRF3	1	0.10	0.33	0.00	0.01	0.06	0.06	0.04	0.26
9/8/2008	1964	DRU1	2	0.10	0.45	0.00	0.01	0.06	0.10	0.04	0.34
9/8/2008	1965	DRU2	3	0.10	0.53	0.00	0.01	0.06	0.12	0.04	0.40
9/8/2008	1966	DRU3	1	0.10	0.18	0.32	0.01	0.06	0.03	-0.27	0.15
9/8/2008	1967	BRF1	2	0.67	2.03	0.32	0.01	0.04	1.20	0.32	0.83
9/8/2008	1968	BRF2	3	0.67	2.17	0.32	0.01	0.04	1.74	0.32	0.42
9/8/2008	1969	BRF3	1	0.67	1.32	0.32	0.01	0.04	0.73	0.32	0.59
9/8/2008	1970	BRU1	2	0.67	1.00	0.32	0.01	0.04	0.35	0.32	0.65
9/8/2008	1971	BRU2	3	0.67	1.02	0.32	0.01	0.04	0.39	0.32	0.61
9/8/2008	1972	BRU3	1	0.67	1.40	0.35	0.01	0.04	1.01	0.29	0.39
9/8/2008	1973	WRF1	2	1.89	0.77	0.35	0.01	0.02	0.15	1.52	0.61
9/8/2008	1974	WRF2	3	1.89	0.81	0.35	0.01	0.02	0.12	1.52	0.68
9/8/2008	1975	WRF3	1	1.89	0.60	0.35	0.01	0.02	0.10	1.52	0.49
9/8/2008	1976	WRU1	2	1.89	0.72	0.35	0.01	0.02	0.13	1.52	0.58

9/8/2008	1977	WRU2	3	1.89	0.88	0.35	0.01	0.02	0.09	1.52	0.77
9/8/2008	1978	WRU3	1	1.89	0.63	0.00	0.01	0.02	0.16	1.86	0.46
9/8/2008	1979	RRF1	2	0.42	0.26	0.00	0.01	0.32	0.10	0.10	0.16
9/8/2008	1980	RRF2	3	0.42	0.30	0.00	0.01	0.32	0.03	0.10	0.27
9/8/2008	1981	RRF3	1	0.42	0.20	0.00	0.01	0.32	0.04	0.10	0.15
9/8/2008	1982	RRU1	2	0.42	0.21	0.00	0.01	0.32	0.10	0.10	0.10
9/8/2008	1983	RRU2	3	0.42	0.23	0.00	0.01	0.32	0.05	0.10	0.17
9/8/2008	1984	RRU3	1	0.42	0.12	0.00	0.00	0.32	0.03	0.10	0.08
9/8/2008	1985	B1F	2	0.42	0.22	0.00	0.01	0.32	0.13	0.10	0.09
9/8/2008	1986	B2F	1	0.42	0.24	0.00	0.01	0.32	0.12	0.10	0.12
9/8/2008	1987	B1U	1	0.42	0.24	0.00	0.01	0.32	0.10	0.10	0.13
9/15/2008	2103	DRF1	1	0.07	0.30	0.00	0.01	0.04	0.05	0.02	0.24
9/15/2008	2104	DRF2	2	0.07	0.34	0.00	0.01	0.04	0.06	0.02	0.27
9/15/2008	2105	DRF3	3	0.07	0.19	0.00	0.01	0.04	0.05	0.02	0.14
9/15/2008	2106	DRU1	1	0.07	0.25	0.00	0.01	0.04	0.07	0.02	0.17
9/15/2008	2107	DRU2	2	0.07	0.32	0.00	0.01	0.04	0.06	0.02	0.25
9/15/2008	2108	DRU3	3	0.07	0.32	0.00	0.01	0.04	0.06	0.02	0.25
9/15/2008	2109	BRF1	1	0.50	1.55	0.19	0.01	0.03	0.71	0.29	0.82
9/15/2008	2110	BRF2	2	0.50	1.64	0.19	0.01	0.03	0.97	0.29	0.66
9/15/2008	2111	BRF3	3	0.50	1.38	0.19	0.01	0.03	0.59	0.29	0.78
9/15/2008	2112	BRU1	1	0.50	0.83	0.19	0.01	0.03	0.22	0.29	0.60
9/15/2008	2113	BRU2	2	0.50	0.62	0.19	0.01	0.03	0.10	0.29	0.51
9/15/2008	2114	BRU3	3	0.50	1.09	0.19	0.01	0.03	0.57	0.29	0.52
9/15/2008	2115	WRF1	1	1.86	0.65	0.40	0.01	0.02	0.13	1.44	0.50
9/15/2008	2116	WRF2	2	1.86	0.81	0.40	0.01	0.02	0.20	1.44	0.60
9/15/2008	2117	WRF3	3	1.86	0.66	0.40	0.02	0.02	0.13	1.44	0.51
9/15/2008	2118	WRU1	1	1.86	0.59	0.40	0.01	0.02	0.09	1.44	0.49
9/15/2008	2119	WRU2	2	1.86	0.68	0.40	0.01	0.02	0.12	1.44	0.54
9/15/2008	2120	WRU3	3	1.86	0.64	0.40	0.01	0.02	0.19	1.44	0.44
9/15/2008	2121	RRF1	1	0.37	0.17	0.00	0.00	0.29	0.08	0.07	0.09
9/15/2008	2122	RRF2	2	0.37	0.27	0.00	0.01	0.29	0.06	0.07	0.21

9/15/2008	2123	RRF3	3	0.37	0.18	0.00	0.01	0.29	0.07	0.07	0.09
9/15/2008	2124	RRU1	1	0.37	0.20	0.00	0.01	0.29	0.09	0.07	0.10
9/15/2008	2125	RRU2	2	0.37	0.23	0.00	0.01	0.29	0.10	0.07	0.13
9/15/2008	2126	RRU3	3	0.37	0.19	0.00	0.01	0.29	0.08	0.07	0.10
9/15/2008	2127	B1F	1	0.37	0.30	0.00	0.01	0.29	0.24	0.07	0.06
9/15/2008	2128	B2F	2	0.37	0.35	0.00	0.01	0.29	0.23	0.07	0.11
9/15/2008	2129	B1U	1	0.37	0.27	0.00	0.01	0.29	0.14	0.07	0.12
9/22/2008	2193	DRF1	1	0.06	0.32	0.01	0.01	0.06	0.05	-0.01	0.26
9/22/2008	2194	DRF2	2	0.06	0.31	0.01	0.01	0.06	0.08	-0.01	0.21
9/22/2008	2195	DRF3	3	0.06	0.39	0.01	0.01	0.06	0.05	-0.01	0.32
9/22/2008	2196	DRU1	1	0.06	0.40	0.01	0.02	0.06	0.08	-0.01	0.31
9/22/2008	2197	DRU2	2	0.06	0.73	0.01	0.01	0.06	0.06	-0.01	0.65
9/22/2008	2198	DRU3	3	0.06	0.42	0.01	0.02	0.06	0.06	-0.01	0.35
9/22/2008	2199	BRF1	1	0.38	0.78	0.22	0.03	0.03	0.53	0.13	0.22
9/22/2008	2200	BRF2	2	0.38	0.66	0.22	0.02	0.03	0.65	0.13	-0.01
9/22/2008	2201	BRF3	3	0.38	1.02	0.22	0.02	0.03	0.43	0.13	0.57
9/22/2008	2202	BRU1	1	0.38	1.14	0.22	0.02	0.03	0.19	0.13	0.93
9/22/2008	2203	BRU2	2	0.38	1.09	0.22	0.02	0.03	0.15	0.13	0.92
9/22/2008	2204	BRU3	3	0.38	1.08	0.22	0.02	0.03	0.49	0.13	0.57
9/22/2008	2205	WRF1	1	1.34	0.89	0.67	0.02	0.02	0.15	0.65	0.72
9/22/2008	2206	WRF2	2	1.34	0.50	0.67	0.03	0.02	0.13	0.65	0.34
9/22/2008	2207	WRF3	3	1.34	0.38	0.67	0.01	0.02	0.06	0.65	0.30
9/22/2008	2208	WRU1	1	1.34	0.90	0.67	0.02	0.02	0.07	0.65	0.81
9/22/2008	2209	WRU2	2	1.34	1.11	0.67	0.02	0.02	0.20	0.65	0.88
9/22/2008	2210	WRU3	3	1.34	1.45	0.67	0.02	0.02	0.20	0.65	1.24
9/22/2008	2211	RRF1	1	0.30	0.91	0.04	0.01	0.23	0.13	0.04	0.78
9/22/2008	2212	RRF2	2	0.30	0.16	0.04	0.01	0.23	0.06	0.04	0.09
9/22/2008	2213	RRF3	3	0.30	0.22	0.04	0.01	0.23	0.05	0.04	0.15
9/22/2008	2214	RRU1	1	0.30	0.18	0.04	0.01	0.23	0.07	0.04	0.11
9/22/2008	2215	RRU2	2	0.30	0.32	0.04	0.01	0.23	0.12	0.04	0.18
9/22/2008	2216	RRU3	3	0.30	0.17	0.04	0.01	0.23	0.07	0.04	0.09

9/22/2008	2217	Blank1F	1	0.30	0.30	0.04	0.06	0.23	0.24	0.04	0.00
9/22/2008	2218	Blank2F	2	0.30	0.33	0.04	0.01	0.23	0.22	0.04	0.10
9/22/2008	2219	Blank1U	1	0.30	0.34	0.04	0.01	0.23	0.24	0.04	0.09
9/29/2008	2252	DRF1	1	0.05	0.18	0.01	0.01	0.04	0.03	0.00	0.14
9/29/2008	2253	DRF2	2	0.05	0.27	0.01	0.01	0.04	0.03	0.00	0.23
9/29/2008	2254	DRF3	3	0.05	0.73	0.01	0.02	0.04	0.05	0.00	0.65
9/29/2008	2255	DRU1	1	0.05	0.24	0.01	0.01	0.04	0.04	0.00	0.20
9/29/2008	2256	DRU2	2	0.05	0.48	0.01	0.01	0.04	0.04	0.00	0.42
9/29/2008	2257	DRU3	3	0.05	0.24	0.01	0.01	0.04	0.05	0.00	0.19
9/29/2008	2258	BRF1	1	0.96	0.88	0.62	0.02	0.05	0.22	0.29	0.64
9/29/2008	2259	BRF2	2	0.96	0.42	0.62	0.02	0.05	0.14	0.29	0.26
9/29/2008	2260	BRF3	3	0.96	0.43	0.62	0.02	0.05	0.06	0.29	0.36
9/29/2008	2261	BRU1	1	0.96	0.78	0.62	0.01	0.05	0.09	0.29	0.67
9/29/2008	2262	BRU2	2	0.96	0.57	0.62	0.01	0.05	0.11	0.29	0.45
9/29/2008	2263	BRU3	3	0.96	0.61	0.62	0.01	0.05	0.18	0.29	0.42
9/29/2008	2264	WRF1	1	1.56	0.59	0.64	0.01	0.03	0.08	0.89	0.50
9/29/2008	2265	WRF2	2	1.56	0.69	0.64	0.04	0.03	0.10	0.89	0.55
9/29/2008	2266	WRF3	3	1.56	0.76	0.64	0.01	0.03	0.17	0.89	0.58
9/29/2008	2267	WRU1	1	1.56	0.38	0.64	0.01	0.03	0.06	0.89	0.31
9/29/2008	2268	WRU2	2	1.56	0.85	0.64	0.01	0.03	0.12	0.89	0.71
9/29/2008	2269	WRU3	3	1.56	0.66	0.64	0.01	0.03	0.15	0.89	0.50
9/29/2008	2270	RRF1	1	0.39	0.15	0.02	0.01	0.33	0.06	0.05	0.08
9/29/2008	2271	RRF2	2	0.39	0.27	0.02	0.01	0.33	0.02	0.05	0.24
9/29/2008	2272	RRF3	3	0.39	0.09	0.02	0.01	0.33	0.01	0.05	0.07
9/29/2008	2273	RRU1	1	0.39	0.15	0.02	0.01	0.33	0.04	0.05	0.10
9/29/2008	2274	RRU2	2	0.39	0.24	0.02	0.01	0.33	0.09	0.05	0.14
9/29/2008	2275	RRU3	3	0.39	0.07	0.02	0.01	0.33	0.02	0.05	0.04
9/29/2008	2276	Blank1F	1	0.39	0.27	0.02	0.01	0.33	0.21	0.05	0.05
9/29/2008	2277	Blank2F	2	0.39	0.21	0.02	0.01	0.33	0.11	0.05	0.10
9/29/2008	2278	Blank1U	1	0.39	0.24	0.02	0.01	0.33	0.16	0.05	0.07
10/5/2008	2434	DRF1	1	0.05	0.13	0.01	0.02	0.04	0.02	-0.02	0.09

10/5/2008	2435	DRF2	2	0.05	0.21	0.01	0.01	0.04	0.03	0.00	0.17
10/5/2008	2436	DRF3	3	0.05	0.29	0.01	0.01	0.04	0.03	0.00	0.25
10/5/2008	2437	DRU1	1	0.05	0.37	0.01	0.01	0.04	0.02	0.00	0.33
10/5/2008	2438	DRU2	2	0.05	0.23	0.01	0.01	0.04	0.03	0.00	0.19
10/5/2008	2439	DRU3	3	0.05	0.18	0.01	0.01	0.04	0.04	0.00	0.13
10/5/2008	2440	BRF1	1	1.00	0.36	0.66	0.03	0.06	0.11	0.88	0.22
10/5/2008	2441	BRF2	2	0.80	0.47	0.52	0.01	0.05	0.16	0.74	0.30
10/5/2008	2442	BRF3	3	1.00	0.44	0.66	0.01	0.06	0.05	0.93	0.39
10/5/2008	2443	BRU1	1	1.00	0.41	0.66	0.01	0.06	0.03	0.93	0.37
10/5/2008	2444	BRU2	2	1.00	0.40	0.66	0.01	0.06	0.07	0.93	0.33
10/5/2008	2445	BRU3	3	1.00	0.42	0.66	0.03	0.06	0.09	0.90	0.30
10/5/2008	2446	WRF1	1	1.34	0.50	0.76	0.01	0.04	0.06	1.29	0.43
10/5/2008	2447	WRF2	2	1.34	0.57	0.76	0.02	0.04	0.14	1.28	0.41
10/5/2008	2448	WRF3	3	1.34	0.35	0.76	0.02	0.04	0.06	1.26	0.26
10/5/2008	2449	WRU1	1	1.34	0.23	0.76	0.00	0.04	0.03	1.29	0.20
10/5/2008	2450	WRU2	2	1.34	0.43	0.76	0.01	0.04	0.06	1.29	0.36
10/5/2008	2451	WRU3	3	1.07	0.40	0.61	0.01	0.03	0.08	1.03	0.31
10/5/2008	2452	RRF1	1	0.34	0.13	0.01	0.01	0.20	0.05	0.14	0.07
10/5/2008	2453	RRF2	2	0.34	0.13	0.01	0.01	0.20	0.04	0.14	0.08
10/5/2008	2454	RRF3	3	0.34	0.07	0.01	0.00	0.20	0.02	0.14	0.05
10/5/2008	2455	RRU1	1	0.34	0.09	0.01	0.01	0.20	0.02	0.14	0.06
10/5/2008	2456	RRU2	2	0.34	0.18	0.01	0.01	0.20	0.06	0.13	0.11
10/5/2008	2457	RRU3	3	0.34	0.11	0.01	0.01	0.20	0.04	0.14	0.07
10/5/2008	2458	Blank1F	1	0.34	0.23	0.01	0.22	0.20	0.14	-0.12	-0.13
10/5/2008	2459	Blank2F	2	0.27	0.13	0.01	0.00	0.16	0.10	0.11	0.03
10/5/2008	2460	Blank1U	1	0.34	0.18	0.01	0.01	0.20	0.11	0.14	0.06
10/13/2008	2466	DRF1	1	0.05	0.27	0.01	0.01	0.04	0.03	0.00	0.22
10/13/2008	2467	DRF2	2	0.05	0.43	0.01	0.02	0.04	0.06	0.00	0.35
10/13/2008	2468	DRF3	3	0.05	0.38	0.01	0.02	0.04	0.04	0.00	0.32
10/13/2008	2469	DRU1	1	0.05	0.31	0.01	0.02	0.04	0.05	0.00	0.24
10/13/2008	2470	DRU2	2	0.05	0.24	0.01	0.01	0.04	0.03	0.00	0.20

10/13/2008	2471	DRU3	3	0.05	0.43	0.01	0.31	0.04	0.05	0.00	0.07
10/13/2008	2472	BRF1	1	0.83	0.90	0.50	0.01	0.06	0.19	0.27	0.70
10/13/2008	2473	BRF2	2	0.83	0.55	0.50	0.02	0.06	0.18	0.27	0.36
10/13/2008	2474	BRF3	3	0.83	0.65	0.50	0.01	0.06	0.11	0.27	0.52
10/13/2008	2475	BRU1	1	0.83	0.97	0.50	0.01	0.06	0.11	0.27	0.84
10/13/2008	2476	BRU2	2	0.83	0.68	0.50	0.01	0.06	0.09	0.27	0.58
10/13/2008	2477	BRU3	3	0.83	0.96	0.50	0.02	0.06	0.22	0.27	0.73
10/13/2008	2478	WRF1	1	1.08	0.54	0.68	0.02	0.04	0.06	0.36	0.46
10/13/2008	2479	WRF2	2	1.08	1.18	0.68	0.03	0.04	0.25	0.36	0.90
10/13/2008	2480	WRF3	3	1.08	0.71	0.68	0.02	0.04	0.09	0.36	0.61
10/13/2008	2481	WRU1	1	1.08	0.41	0.68	0.01	0.04	0.03	0.36	0.37
10/13/2008	2482	WRU2	2	1.08	0.83	0.68	0.02	0.04	0.09	0.36	0.72
10/13/2008	2483	WRU3	3	1.08	0.96	0.68	0.02	0.04	0.17	0.36	0.77
10/13/2008	2484	RRF1	1	0.10	0.10	0.01	0.01	0.03	0.04	0.06	0.05
10/13/2008	2485	RRF2	2	0.10	0.06	0.01	0.01	0.03	0.01	0.06	0.05
10/13/2008	2486	RRF3	3	0.10	0.06	0.01	0.00	0.03	0.01	0.06	0.05
10/13/2008	2487	RRU1	1	0.10	0.14	0.01	0.01	0.03	0.03	0.06	0.10
10/13/2008	2488	RRU2	2	0.10	0.14	0.01	0.01	0.03	0.06	0.06	0.07
10/13/2008	2489	RRU3	3	0.10	0.06	0.01	0.01	0.03	0.01	0.06	0.04
10/13/2008	2490	Blank1F	1	0.10	0.26	0.01	0.01	0.03	0.17	0.06	0.08
10/13/2008	2491	Blank2F	2	0.10	0.24	0.01	0.01	0.03	0.17	0.06	0.07
10/13/2008	2492	Blank1U	1	0.10	0.20	0.01	0.01	0.03	0.14	0.06	0.06
10/19/2008	2542	DRF1	1	0.06	0.18	0.01	0.03	0.04	0.03	0.01	0.12
10/19/2008	2543	DRF2	2	0.06	0.45	0.01	0.02	0.04	0.04	0.01	0.39
10/19/2008	2544	DRF3	3	0.06	0.37	0.01	0.03	0.04	0.03	0.01	0.31
10/19/2008	2545	DRU1	1	0.06	0.42	0.01	0.09	0.04	0.04	0.01	0.29
10/19/2008	2546	DRU2	2	0.06	0.29	0.01	0.01	0.04	0.03	0.01	0.25
10/19/2008	2547	DRU3	3	0.06	0.31	0.01	0.02	0.04	0.05	0.01	0.23
10/19/2008	2548	BRF1	1	0.23	13.75	0.16	0.02	0.03	0.11	0.04	13.63
10/19/2008	2549	BRF2	2	0.23	0.00	0.16	0.02	0.03	0.19	0.04	-0.21
10/19/2008	2550	BRF3	3	0.23	1.16	0.16	0.03	0.03	0.15	0.04	0.98

10/19/2008	2551	BRU1	1	0.23	0.55	0.16	0.02	0.03	0.05	0.04	0.49
10/19/2008	2552	BRU2	2	0.23	0.44	0.16	0.02	0.03	0.07	0.04	0.35
10/19/2008	2553	BRU3	3	0.23	1.07	0.16	0.02	0.03	0.13	0.04	0.92
10/19/2008	2554	WRF1	1	0.92	0.59	0.47	0.02	0.03	0.09	0.42	0.47
10/19/2008	2555	WRF2	2	0.92	0.46	0.47	0.02	0.03	0.11	0.42	0.33
10/19/2008	2556	WRF3	3	0.92	0.79	0.47	0.02	0.03	0.08	0.42	0.69
10/19/2008	2557	WRU1	1	0.92	0.54	0.47	0.02	0.03	0.03	0.42	0.49
10/19/2008	2558	WRU2	2	0.92	0.55	0.47	0.02	0.03	0.06	0.42	0.47
10/19/2008	2559	WRU3	3	0.92	0.82	0.47	0.02	0.03	0.17	0.42	0.63
10/19/2008	2560	RRF1	1	0.08	1.51	0.01	0.01	0.01	0.04	0.06	1.46
10/19/2008	2561	RRF2	2	0.08	0.06	0.01	0.01	0.01	0.01	0.06	0.03
10/19/2008	2562	RRF3	3	0.08	0.06	0.01	0.01	0.01	0.01	0.06	0.04
10/19/2008	2563	RRU1	1	0.08	0.06	0.01	0.01	0.01	0.01	0.06	0.04
10/19/2008	2564	RRU2	2	0.08	0.13	0.01	0.01	0.01	0.04	0.06	0.08
10/19/2008	2565	RRU3	3	0.08	0.04	0.01	0.10	0.01	0.03	0.06	-0.09
10/19/2008	2566	Blank1F	1	0.08	0.20	0.01	0.01	0.01	0.22	0.06	-0.03
10/19/2008	2567	Blank2F	2	0.08	0.16	0.01	0.21	0.01	0.14	0.06	-0.19
10/19/2008	2568	Blank1U	1	0.08	0.19	0.01	0.01	0.01	0.15	0.06	0.02
10/26/2008	2627	DRF1	1	0.07	0.25	0.01	0.01	0.05	0.03	0.01	0.21
10/26/2008	2628	DRF2	2	0.07	0.24	0.01	0.02	0.05	0.03	0.01	0.19
10/26/2008	2629	DRF3	3	0.07	0.25	0.01	0.01	0.05	0.04	0.01	0.20
10/26/2008	2630	DRU1	1	0.07	0.29	0.01	0.02	0.05	0.03	0.01	0.24
10/26/2008	2631	DRU2	2	0.07	0.42	0.01	0.02	0.05	0.06	0.01	0.34
10/26/2008	2632	DRU3	3	0.07	0.22	0.01	0.01	0.05	0.05	0.01	0.16
10/26/2008	2633	BRF1	1	0.76	0.37	0.71	0.01	0.09	0.06	-0.04	0.30
10/26/2008	2634	BRF2	2	0.76	0.35	0.71	0.02	0.09	0.09	-0.04	0.25
10/26/2008	2635	BRF3	3	0.76	0.59	0.71	0.01	0.09	0.08	-0.04	0.50
10/26/2008	2636	BRU1	1	0.76	0.47	0.71	0.01	0.09	0.05	-0.04	0.41
10/26/2008	2637	BRU2	2	0.76	0.54	0.71	0.01	0.09	0.08	-0.04	0.44
10/26/2008	2638	BRU3	3	0.76	0.45	0.71	0.01	0.09	0.06	-0.04	0.37
10/26/2008	2639	WRF1	1	2.36	0.83	1.04	0.04	0.08	0.14	1.23	0.65

10/26/2008	2640	WRF2	2	2.36	0.35	1.04	0.02	0.08	0.14	1.23	0.18
10/26/2008	2641	WRF3	3	2.36	0.26	1.04	0.01	0.08	0.07	1.23	0.18
10/26/2008	2642	WRU1	1	2.36	0.27	1.04	0.01	0.08	0.06	1.23	0.20
10/26/2008	2643	WRU2	2	2.36	0.38	1.04	0.01	0.08	0.05	1.23	0.31
10/26/2008	2644	WRU3	3	2.36	0.60	1.04	0.01	0.08	0.13	1.23	0.46
10/26/2008	2645	RRF1	1	0.43	0.13	0.01	0.03	0.38	0.06	0.04	0.04
10/26/2008	2646	RRF2	2	0.43	0.09	0.01	0.01	0.38	0.05	0.04	0.03
10/26/2008	2647	RRF3	3	0.43	0.13	0.01	0.01	0.38	0.05	0.04	0.07
10/26/2008	2648	RRU1	1	0.43	0.12	0.01	0.01	0.38	0.07	0.04	0.04
10/26/2008	2649	RRU2	2	0.43	0.19	0.01	0.01	0.38	0.10	0.04	0.08
10/26/2008	2650	RRU3	3	0.43	0.18	0.01	0.01	0.38	0.09	0.04	0.08
10/26/2008	2651	Blank1F	1	0.43	0.23	0.01	0.01	0.38	0.16	0.04	0.06
10/26/2008	2652	Blank2F	2	0.43	0.31	0.01	0.02	0.38	0.22	0.04	0.07
10/26/2008	2653	Blank1U	1	0.43	0.23	0.01	0.01	0.38	0.14	0.04	0.07

Appendix E. Initial soil and sand carbon and nitrogen (analysis by the forestry laboratory)

Lab	Matrix	SOIL	%C	%N	C:N
Forestry	Soil	1	1.90	0.05	39.54
Forestry	Soil	2	1.67	0.04	42.69
Forestry	Soil	3	1.68	0.04	38.27
Forestry	Sand	1	0.04	0.00	-
Forestry	Sand	2	0.04	0.00	-
Forestry	Sand	3	0.05	0.00	-

Appendix F. Organic layer carbon and nitrogen at 20 weeks (analysis by the DeLaune laboratory)

Sample #	Sample Id	Rep. #	% Nitrogen	%Carbon	C:N
1	DRF	1	0.061	1.422	23.31
2	DRF	2	0.061	1.545	25.33
3	DRF	3	0.056	1.491	26.63
4	DRU	1	0.054	1.622	30.04
5	DRU	2	0.048	1.619	33.73
6	DRU	3	0.035	1.505	43.00
7	BRF	1	0.056	1.821	32.52
8	BRF	2	0.051	1.258	24.67
9	BRF	3	0.046	1.511	32.85
10	BRU	1	0.053	1.402	26.45
11	BRU	2	0.044	1.641	37.30
12	BRU	3	0.057	1.755	30.79
13	WRF	1	0.06	1.815	30.25
14	WRF	2	0.054	1.625	30.09
15	WRF	3	0.065	1.624	24.98
16	WRU	1	0.039	1.586	40.67
17	WRU	2	0.056	1.581	28.23
18	WRU	3	0.05	1.316	26.32
19	RRF	1	0.055	1.303	23.69
20	RRF	2	0.054	1.309	24.24
21	RRF	3	0.075	1.837	24.49
22	RRU	1	0.082	2.257	27.52
23	RRU	2	0.066	1.748	26.48
24	RRU	3	0.058	1.492	25.72
25	BLANK	1F	0.057	1.267	22.23
26	BLANK	2F	0.053	1.129	21.30
27	BLANK	2U	0.0505	1.656	32.79
27A	BLANK	1U	0.05103	1.56	30.57

Appendix G. Carbon and nitrogen in sand at 0-5 cm at 20 weeks. (analysis by the DeLaune laboratory)

Sample #	Sample Id	Rep. #	% Nitrogen	%Carbon
28	DRF	1	0.0001	0.037
29	DRF	2	0.0001	0.022
30	DRF	3	0.003	0.033
31	DRU	1	nd	nd
32	DRU	2	0.002	0.054
33	DRU	3	0.001	0.073
34	BRF	1	0.001	0.084
35	BRF	2	0.0001	0.028
36	BRF	3	0.0001	0.034
37	BRU	1	0.0001	0.02
38	BRU	2	0.0001	0.039
39	BRU	3	0.001	0.027
40	WRF	1	0.001	0.028
41	WRF	2	nd	nd
42	WRF	3	0.004	0.05
43	WRU	1	0.004	0.064
44	WRU	2	0.0001	0.044
45	WRU	3	0.001	0.055
46	RRF	1	0.005	0.017
47	RRF	2	0.005	0.021
48	RRF	3	0.0001	0.039
49	RRU	1	0.001	0.022
50	RRU	2	0.0001	0.022
51	RRU	3	0.001	0.015
52	BLANK	1F	0.001	0.019
53	BLANK	2F	0.0001	0.021
54	BLANK	2U	0.002	0.012
55	BLANK	2U	0.002	0.014

Appendix H. Carbon and nitrogen in sand at 5-9 cm at 20 weeks. (analysis by the DeLaune laboratory)

Sample #	Sample Id	Rep. #	% Nitrogen	%Carbon
55	DRF	1	0.001	0.015
56	DRF	2	0.0001	0.013
57	DRF	3	0.001	0.014
58	DRU	1	0.003	0.084
59	DRU	2	0.001	0.013
60	DRU	3	0.0001	0.018
61	BRF	1	0.001	0.019
62	BRF	2	0.001	0.012
63	BRF	3	0.0001	0.018
64	BRU	1	0.001	0.014
65	BRU	2	0.001	0.012
66	BRU	3	0.003	0.015
67	WRF	1	0.002	0.018
68	WRF	2	0.0001	0.016
69	WRF	3	0.001	0.017
70	WRU	1	0.001	0.023
71	WRU	2	0.001	0.017
72	WRU	3	0.004	0.015
73	RRF	1	0.006	0.018
74	RRF	2	0.001	0.014
75	RRF	3	0.0001	0.02
76	RRU	1	0.0001	0.012
77	RRU	2	0.001	0.05
78	RRU	3	0.0001	0.03
79	BLANK	1F	0.0001	0.017
80	BLANK	2F	0.001	0.018
81	BLANK	2U	0.034	0.01
82	BLANK	2U	0.036	0.015

Appendix I. Foliar carbon and nitrogen before treatments commenced

Date	Seed tray	%C	%N
6/5/2008	RF 1	36.95	1.04
6/5/2008	RF 2	37.48	1.07
6/5/2008	RF 3	37.88	1.17
6/5/2008	RF 4	37.94	1.19
6/5/2008	RF 5	38.73	1.18
6/5/2008	RF 6	37.91	1.18
6/5/2008	RUF 1	36.65	1.08
6/5/2008	RUF 2	36.77	1.16
6/5/2008	RUF 3	36.78	1.09
6/5/2008	RUF 4	36.89	1.07
6/5/2008	RUF 5	36.39	1.09
6/5/2008	RUF 6	37.01	1.02

Appendix J. Foliage carbon and nitrogen at 4 weeks

TIME = 4 wks Date	Sample ID	Rep	%N	%C	C:N
7/9/2008	BRF	1	1.80	38.49	21.40
7/9/2008	BRF	2	1.78	38.91	21.91
7/9/2008	BRF	3	1.87	38.66	20.64
7/9/2008	BRU	1	1.74	38.38	22.02
7/9/2008	BRU	2	1.82	38.92	21.43
7/9/2008	BRU	3	1.80	38.85	21.59
7/9/2008	DRF	1	1.42	38.52	27.04
7/9/2008	DRF	2	1.81	38.53	21.33
7/9/2008	DRF	3	1.93	39.36	20.43
7/9/2008	DRU	1	1.55	39.24	25.35
7/9/2008	DRU	2	1.62	38.75	23.94
7/9/2008	DRU	3	1.71	38.76	22.68
7/9/2008	RRF	1	1.79	39.72	22.24
7/9/2008	RRF	2	1.41	39.31	27.82
7/9/2008	RRF	3	1.38	39.28	28.56
7/9/2008	RRU	1	1.48	38.89	26.22
7/9/2008	RRU	2	1.51	38.34	25.40
7/9/2008	RRU	3	1.62	38.44	23.67
7/9/2008	WRF	1	2.17	38.57	17.77
7/9/2008	WRF	2	1.98	39.46	19.90
7/9/2008	WRF	3	1.99	38.88	19.50
7/9/2008	WRU	1	1.71	39.39	23.04
7/9/2008	WRU	2	1.84	38.16	20.71
7/9/2008	WRU	3	1.90	38.35	20.22

Appendix K. Foliage carbon and nitrogen at 20 weeks

Date	Sample ID	Rep	%N	%C	C:N
10/29/2008	BRF	1	2.80	43.90	15.69
10/29/2008	BRF	2	3.38	44.27	13.10
10/29/2008	BRF	3	2.86	43.13	15.09
10/29/2008	BRU	1	2.70	44.08	16.31
10/29/2008	BRU	2	2.90	42.71	14.75
10/29/2008	BRU	3	2.63	44.24	16.81
10/29/2008	DRF	1	2.44	42.66	17.52
10/29/2008	DRF	2	2.47	42.35	17.14
10/29/2008	DRF	3	2.61	41.71	15.96
10/29/2008	DRU	1	2.35	42.87	18.26
10/29/2008	DRU	2	2.55	42.13	16.51
10/29/2008	DRU	3	2.55	42.04	16.46
10/29/2008	RRF	1	2.58	41.17	15.94
10/29/2008	RRF	2	2.45	42.24	17.27
10/29/2008	RRF	3	2.06	41.72	20.24
10/29/2008	RRU	1	2.28	42.24	18.51
10/29/2008	RRU	2	2.58	43.42	16.83
10/29/2008	RRU	3	2.03	42.07	20.68
10/29/2008	WRF	1	2.95	44.24	14.98
10/29/2008	WRF	2	3.38	44.12	13.04
10/29/2008	WRF	3	2.92	43.23	14.79
10/29/2008	WRU	1	2.64	43.57	16.52
10/29/2008	WRU	2	2.51	43.92	17.48
10/29/2008	WRU	3	2.87	43.07	14.98

Appendix L. Input irrigation water chemistry

Use Date	Type	A&M code	DOC	TDN	NO_3-N	NH_4-N	PO_4-P	HCO_3^-	Na^+	K^+	Mg^{2+}	Ca^{2+}
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
6/9/2008	Bath	873	0.35	0.38	0.16	0.43	0.56	248.70	193.77	5.73	0.32	2.00
6/16/2008	Bath	873	0.35	8.15	0.15	0.55	0.19	336.33	193.77	5.73	0.32	2.00
6/23/2008	Bath	873	0.35	8.15	0.15	0.55	0.19	336.33	193.77	5.73	0.32	2.00
6/30/2008	Bath	873	0.35	8.15	0.15	0.55	0.19	336.33	193.77	5.73	0.32	2.00
7/7/2008	Bath	1102	20.40	3.50	0.16	0.17	0.26	374.47	155.69	4.09	0.55	2.75
7/14/2008	Bath	1276	8.49	4.40	0.11	1.42	0.15	365.97	154.77	3.72	0.45	2.76
7/21/2008	Bath	1352	11.08	5.10	0.08	1.69	0.18	374.07	203.76	5.92	0.59	3.69
7/28/2008	Bath	1386	83.54	900.0	900.0	7.87	0.52	380.46	206.72	13.7	0.89	2.84
8/4/2008	Bath	1448	40.62	1130.0	1130.0	32.21	2.58	629.62	256.60	17.2	0.35	3.09
8/11/2008	Bath	1636	26.27	77.30	0.06	36.14	3.43	646.88	252.90	16.8	1.38	4.30
8/18/2008	Bath	1668	16.74	57.00	0.09	20.60	2.62	425.31	243.09	15.9	1.36	3.79
8/25/2008	Bath	1760	6.76	2.40	0.52	0.41	0.04	323.19	196.58	3.21	0.52	2.63
9/1/2008	Bath	1858	7.14	3.01	0.13	0.83	0.03	357.60	199.24	3.35	0.57	3.36
9/9/2008	Bath	1989	2.93	2.93	0.16	1.38	0.02	375.78	193.76	2.96	0.60	3.76
9/15/2008	Bath	2131	4.33	2.19	0.13	0.82	0.06	342.70	197.34	2.92	0.47	1.62
9/22/2008	Bath	2221	4.07	1.66	0.11	0.96	0.03	327.82	172.49	2.74	0.38	1.14
9/29/2008	Bath	2280	11.22	4.18	0.23	2.68	0.01	353.18	195.64	4.06	0.38	1.04
10/5/2008	Bath	2462	7.59	4.34	0.25	2.85	0.02	349.08	202.17	4.28	0.38	0.90
10/12/2008	Bath	2494	6.18	3.62	0.25	2.19	0.07	342.78	204.75	4.44	0.38	1.01
10/19/2008	Bath	2570	3.68	1.00	0.12	0.71	0.05	315.18	88.76	1.53	0.14	0.68
10/26/2008	Bath	2655	34.19	2.75	0.32	2.57	0.02	347.82	194.13	3.00	0.33	1.00
6/9/2008	Tap	808	1.01	0.24	0.22	0.02	0.06	396.20	232.86	2.01	0.48	3.54
6/16/2008	Tap	808	1.01	0.24	0.22	0.02	0.06	396.20	232.86	2.01	0.48	3.54

6/23/2008	Tap	808	1.01	0.24	0.22	0.02	0.06	339.32	232.86	2.01	0.48	3.54
6/30/2008	Tap	808	1.01	0.24	0.22	0.02	0.06	339.32	232.86	2.01	0.48	3.54
7/7/2008	Tap	808	1.01	0.24	0.22	0.02	0.06	339.32	232.86	2.01	0.48	3.54
7/14/2008	Tap	1278	0.18	0.24	0.15	0.05	0.17	309.53	183.69	1.73	0.41	2.83
7/21/2008	Tap	1354	0.78	0.24	0.15	0.03	0.15	361.86	192.08	2.01	0.42	3.23
7/28/2008	Tap	1388	2.21	670.00	670.00	0.03	0.15	330.55	183.69	1.78	0.47	3.34
8/4/2008	Tap	1450	1.35	0.40	0.16	0.11	0.18	325.94	218.56	1.76	0.32	3.01
8/11/2008	Tap	1638	0.98	0.21	0.18	0.05	0.19	381.28	212.76	1.64	0.47	4.21
8/18/2008	Tap	1670	1.10	0.09	0.11	0.02	0.17	365.45	221.74	1.60	0.42	2.81
8/25/2008	Tap	1762	0.58	0.26	0.44	0.02	0.21	315.66	191.14	1.51	0.42	3.24
9/1/2008	Tap	1860	0.94	0.05	0.08	0.02	0.13	352.44	211.37	1.67	0.47	3.60
9/9/2008	Tap	1991	0.43	0.43	0.25	0.02	0.15	374.42	211.37	1.67	0.47	3.60
9/15/2008	Tap	2133	1.78	0.31	0.19	0.02	0.17	340.75	166.13	1.45	0.32	2.19
9/22/2008	Tap	2223	0.85	0.27	0.27	0.03	0.17	359.55	212.32	8.48	0.37	2.29
9/29/2008	Tap	2282	1.15	0.20	0.16	0.04	0.16	253.48	140.79	1.23	0.25	1.76
10/5/2008	Tap	2464	1.18	0.27	0.22	0.07	0.16	353.40	219.21	8.79	0.37	2.21
10/12/2008	Tap	2496	0.80	0.23	0.18	0.03	0.30	335.63	203.98	7.75	0.39	2.54
10/19/2008	Tap	2572	0.97	0.24	0.16	0.04	0.31	337.80	210.15	7.89	0.41	2.51
10/26/2008	Tap	2657	1.01	0.24	0.17	0.04	0.32	349.28	179.70	1.32	0.32	2.47
6/9/2008	Machine	874	58.30	8.15	0.15	0.55	0.19	336.33	143.45	4.85	0.49	2.16
6/16/2008	Machine	874	58.30	0.38	0.16	0.43	0.56	248.70	143.45	4.85	0.49	2.16
6/23/2008	Machine	874	58.30	0.38	0.16	0.43	0.56	248.70	143.45	4.85	0.49	2.16
6/30/2008	Machine	874	58.30	0.38	0.16	0.43	0.56	248.70	143.45	4.85	0.49	2.16
7/7/2008	Machine	1101	67.51	7.89	0.13	0.53	0.17	739.27	149.30	3.98	0.31	2.35
7/14/2008	Machine	1275	30.91	8.84	0.05	2.23	0.04	368.11	183.35	4.97	0.48	2.70
7/21/2008	Machine	1353	27.74	10.65	0.06	3.09	0.01	386.53	207.96	6.76	0.50	2.73
7/28/2008	Machine	1385	85.98	640.00	640.00	0.18	0.02	361.41	187.88	2.64	0.16	0.85
8/4/2008	Machine	1447	64.14	650.00	650.00	1.06	0.02	325.82	215.01	3.92	0.46	2.04
8/11/2008	Machine	1635	42.53	8.43	0.09	0.97	0.04	364.91	168.66	3.29	0.38	1.13

8/18/2008	Machine	1667	31.34	7.97	0.16	1.33	0.06	380.04	227.23	4.23	0.42	1.92
8/25/2008	Machine	1759	52.62	5.09	0.32	0.27	0.02	317.40	200.94	3.92	0.40	2.74
9/1/2008	Machine	1857	34.14	6.42	0.08	0.89	0.03	360.66	200.71	3.89	0.41	2.58
9/9/2008	Machine	1988	36.44	8.21	0.10	1.50	0.03	373.37	210.08	3.07	0.44	2.06
9/15/2008	Machine	2130	50.12	8.07	0.07	1.76	0.02	342.93	199.85	3.85	0.30	1.35
9/22/2008	Machine	2220	26.95	5.84	0.08	2.92	0.04	307.61	165.28	2.91	0.31	1.27
9/29/2008	Machine	2279	36.80	6.79	0.15	2.80	0.02	365.46	198.94	3.91	0.28	1.36
10/5/2008	Machine	2461	27.88	5.83	0.17	3.29	0.02	356.74	212.39	4.24	0.28	1.39
10/12/2008	Machine	2493	26.93	4.69	0.18	2.95	0.03	355.01	234.89	4.94	0.34	1.71
10/19/2008	Machine	2569	25.07	4.00	0.14	2.06	0.04	369.40	224.84	4.58	0.34	1.53
10/26/2008	Machine	2654	54.72	8.54	0.30	3.77	0.03	389.69	217.12	5.76	0.31	1.50
8/4/2008	Rain	1449	60.00	60.00	60.00	0.03	0.01	25.78	8.32	0.44	0.31	8.87
8/11/2008	Rain	1637	9.69	1.05	0.55	0.02	0.02	27.66	18.02	1.06	0.50	7.06
8/18/2008	Rain	1669	9.44	2.12	1.14	0.40	0.07	31.48	11.64	0.61	0.35	8.52
8/25/2008	Rain	1761	10.28	1.17	1.10	0.02	0.01	25.26	12.78	0.45	0.38	7.97
9/1/2008	Rain	1859	10.16	0.56	0.31	0.02	0.01	23.51	17.52	0.45	0.38	7.65
9/9/2008	Rain	1990	1.82	1.82	1.37	0.01	0.04	20.30	17.77	0.46	0.43	8.07
9/15/2008	Rain	2132	10.66	1.59	1.25	0.02	0.01	20.25	8.43	0.44	0.37	5.93
9/22/2008	Rain	2222	9.38	1.32	0.99	0.15	0.01	22.21	8.91	2.32	0.35	5.93
9/29/2008	Rain	2281	8.76	1.71	1.43	0.09	0.04	19.06	16.01	0.44	0.36	5.57
10/5/2008	Rain	2463	9.62	1.48	0.85	0.04	0.01	25.09	11.71	2.55	0.37	5.74
10/12/2008	Rain	2495	8.36	0.45	0.15	0.05	0.01	25.64	15.31	1.75	0.38	5.65
10/19/2008	Rain	2571	9.69	0.34	0.05	0.05	0.04	44.54	29.53	2.52	0.35	4.02
10/26/2008	Rain	2656	7.63	1.55	1.36	0.05	0.06	36.45	31.59	2.36	0.13	1.93
6/9/2008	Rain	856	3.18	1.10	0.53	0.10	0.05	15.52	17.69	0.58	0.38	5.65
6/16/2008	Rain	856	3.18	1.10	0.53	0.10	0.05	15.52	17.69	0.58	0.38	5.65
6/23/2008	Rain	856	3.18	1.10	0.53	0.10	0.05	15.52	17.69	0.58	0.38	5.65
6/30/2008	Rain	856	3.18	1.10	0.53	0.10	0.05	15.52	17.69	0.58	0.38	5.65
7/7/2008	Rain	1103	5.24	1.24	0.86	0.03	0.04	26.89	17.69	0.58	0.38	5.65

7/14/2008	Rain	1277	1.25	0.69	0.90	0.03	0.01	28.23	19.26	0.68	0.32	4.90
7/21/2008	Rain	1351	70.00	70.00	70.00	0.02	0.00	29.09	15.69	0.65	0.24	3.08
7/28/2008	Rain	1387	60.00	60.00	60.00	0.15	0.08	31.79	62.53	1.52	0.52	6.07

VITA

Name: Leon Carl Holgate

Address: P.O. Box 9320

College Station, TX 77842

Email Address: leonhlgt@gmail.com

Education: B.S., Animal Science, Prairie View A&M University, 2006

M.S., Soil Science, Texas A&M University, 2009

Honors and Awards

Department of Soil and Crop Sciences Assistantship

2008-2009 Mills Scholarship (Texas Water Resource Institute)

Publications (Conference Abstracts)

Holgate L, Gentry T and Aitkenhead-Peterson J A. Irrigation source water: effect on soil and plant nutrient cycling. Abstract 42920. Section A06 International Agronomy. 2008 Joint meeting of the GSA, SSSA-ASA-CSSA, October 5th-9th, Houston,